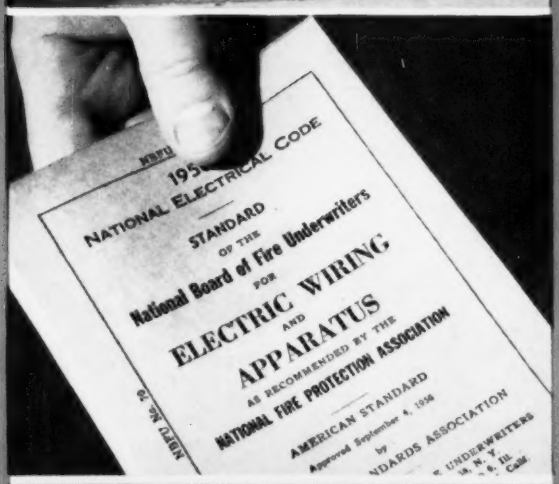
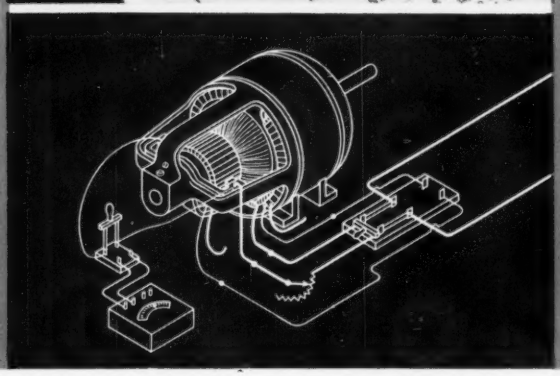
75th Year of service to the advancing power field

Power

FEBRUARY 1957
ONE DOLLAR
A McGRAW-HILL PUBLICATION





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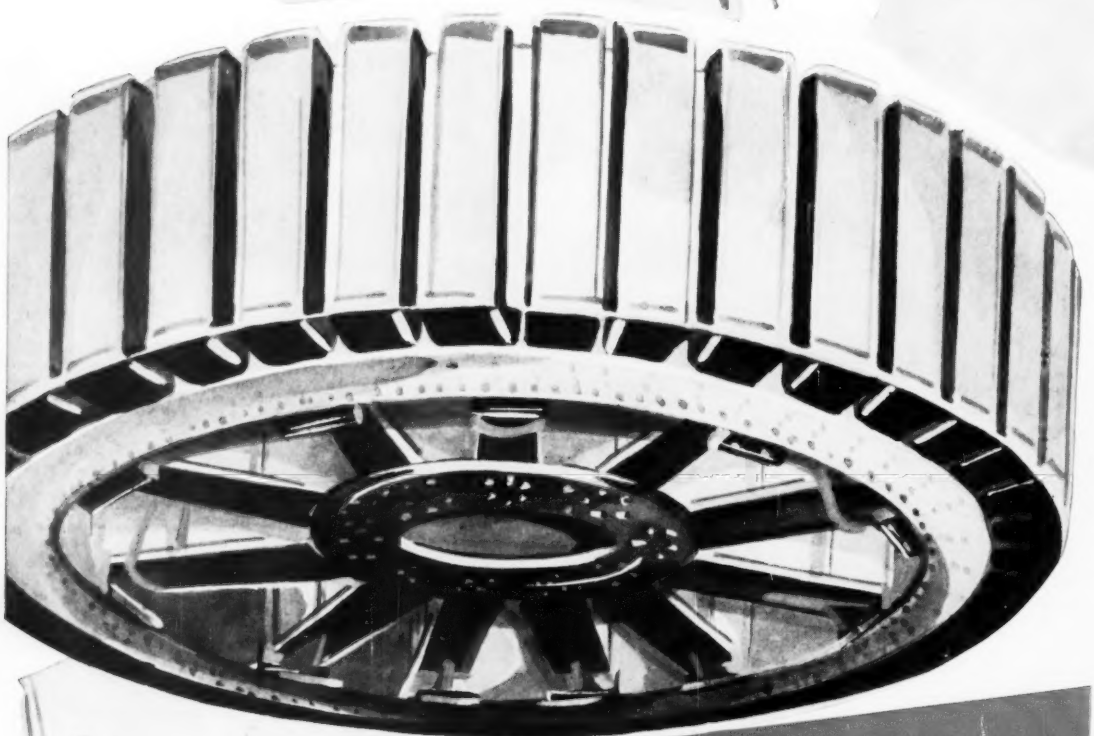
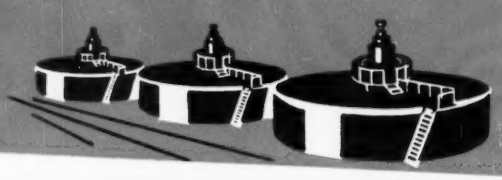
Hundred-and-seventy Tons



. . . the weight of this salient-pole rotor. Revolving at 136.4 rev/min it will help generate electricity in a modern AEG water-power alternator.

These rotors can have peripheral speeds of up to 620 ft/sec.; in service, the load on the thrust bearing may reach 1200 tons and above.

The design of every component part of these AEG alternators, both large and small, gives factual evidence of much practical experience gathered over many years. The cumulative effect of continued and patient detail work has greatly contributed to the world-wide reputation of AEG.



AEG

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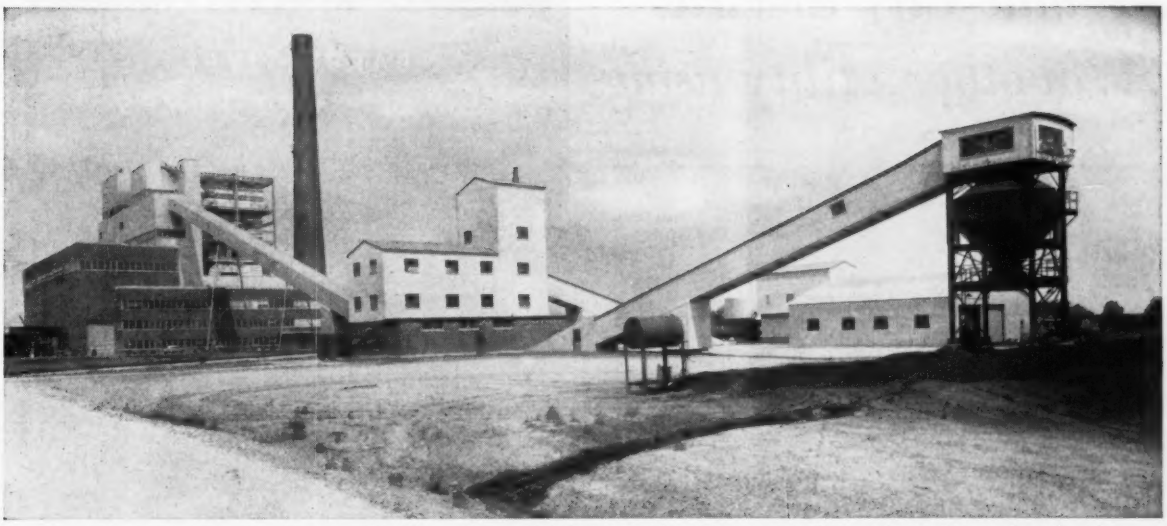
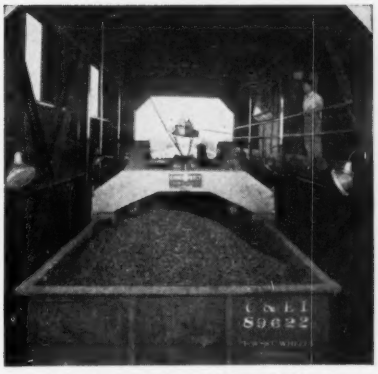
ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT

Berlin (West) EXPORT DEPARTMENT Frankfurt (Main)

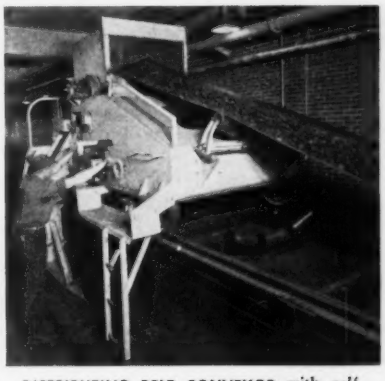


VERMILION STATION power plant, Danville, Ill., employs a Link-Belt system for fast, economical conveying and processing of coal.



LINK-BELT CAR SHAKER with exclusive, low-frequency vibration quickly frees packed coal—empties hopper bottom cars fast.

INCLINED BELT CONVEYOR, 30-in. wide, delivers coal to top of bunkers where it is discharged to distributing belt conveyor.



DISTRIBUTING BELT CONVEYOR with *self-propelled* tripper discharges coal to bunkers through dust-tight bin seal.

33% EXPANDABILITY

built into Vermilion Station's coal handling system

LINK-BELT engineering and equipment provide for future load increase

RAPID growth of population and industry—with corresponding need for more electricity—is a vital consideration in modern power plant design. That's why Illinois Power Company, in planning the Vermilion Station, sought an efficient coal handling system that could satisfy expected expansion.

Link-Belt, with its cumulative experience gained in thousands of similar installations, was selected for the project. And, working with Sargent and Lundy, consulting engineers, furnished a complete coal handling system able to process 300 tph . . . with provision to easily increase capacity to 400 tons when needed.

This plant is just one of many benefiting from the proved effectiveness, the maximum simplicity and economy of Link-Belt equipment. For all your coal handling problems—unloading, storing, weighing, reclaiming, elevating, feeding—Link-Belt can supply a low-cost-per-ton solution.

You can get full information at your nearest Link-Belt office or from Book 2410. It shows the latest layouts and equipment for power plants, large and small.

14,278

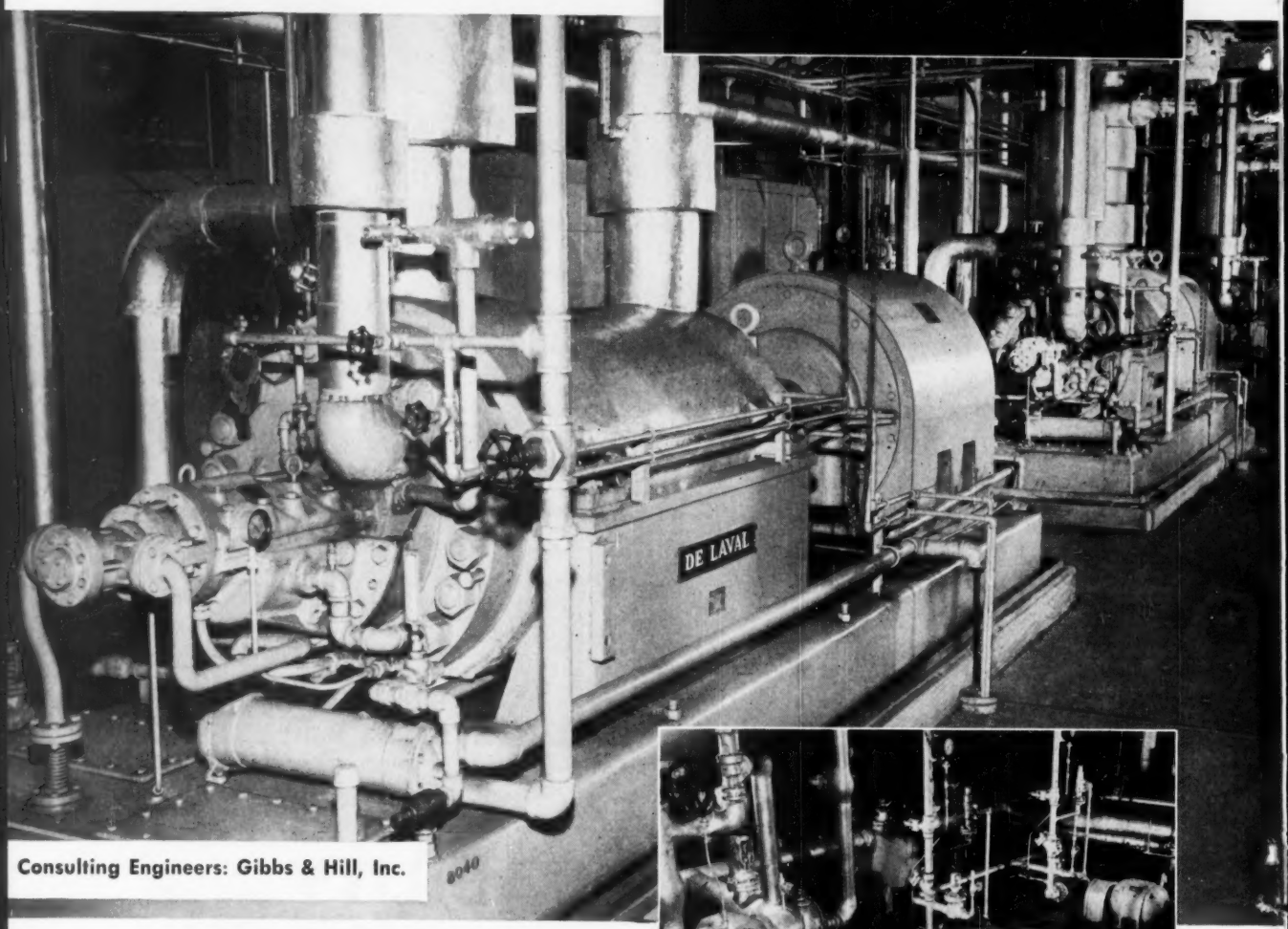
LINK-BELT

COAL HANDLING EQUIPMENT

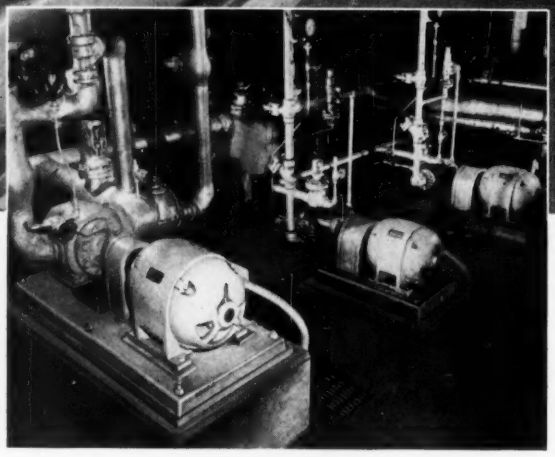
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

Atlantic City Electric ... another utility using

DE LAVAL
BARREL TYPE BOILER FEED PUMPS



Consulting Engineers: Gibbs & Hill, Inc.



De Laval IMO rotary positive displacement pumps handle heavy fuel oil. They are used for standby operation.

Atlantic City Electric Co. and Gibbs & Hill, Inc., Consulting Engineers, know that they can count on De Laval reliability. That's why they selected three De Laval high pressure barrel type boiler feed pumps for the Deepwater Station in Penns Grove, New Jersey. These 10-stage units deliver 675 gpm, operating at 1762 psi with temperature at 287 F. The pumps are driven by 900 hp motors.

De Laval barrel type boiler feed pumps operate at pressures up to 5500 psi. These units offer many important design advantages, such as double volute diaphragm, individual diaphragm bolting, only one inner high-pressure joint, and bare shaft construction. Their dependability is proven by year in, year out service in public utilities and industrial plants.

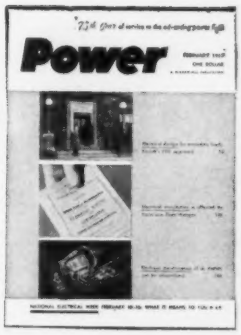
Send for De Laval Bulletin 1506, which contains helpful data.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY
815 Nottingham Way, Trenton 2, New Jersey

Power

FEBRUARY 1957 • VOLUME 101 NUMBER 2



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Print order this issue: 48,532

NATIONAL ELECTRICAL WEEK sets the theme for this month's cover. Coinciding with the birthday of Thomas Edison, which falls during the week of February 10-16 NEW aims ". . . to focus attention on the contributions of electricity to our American way of life and on the contributions toward the economic strength of our country and of the organizations which make up the electrical industry . . .".

Three articles, plus, the Foreword, are keyed to NEW. They serve to remind us of the forward strides being taken in a few phases of the electrical power field.

Next month . . .

"The Mongoose Waltz" which made newspaper headlines a few weeks back, serves as a springboard for an upcoming article on ways to work a lead through underground duct. You may recall the role of the mongoose as a string carrier through a long pipe run beneath the New Jersey Turnpike.

We're sticking closely to the proven methods of tackling the job . . . without benefit of our small furry friends.

Plant ventilation can be a knotty problem when basic laws of physics are ignored. March article outlines the real reasons for poor performance, based on many of the common errors being made today while planning.

Industrial TV continues to find new applications, at the same time posing some tricky installation problems. Look for the latest on-the-job info.

. . . and a future month

Belts and chains, as used in mechanical power transmission, is subject of May special report. Watch for it!

February 1957 POWER Vol. 101—No. 2

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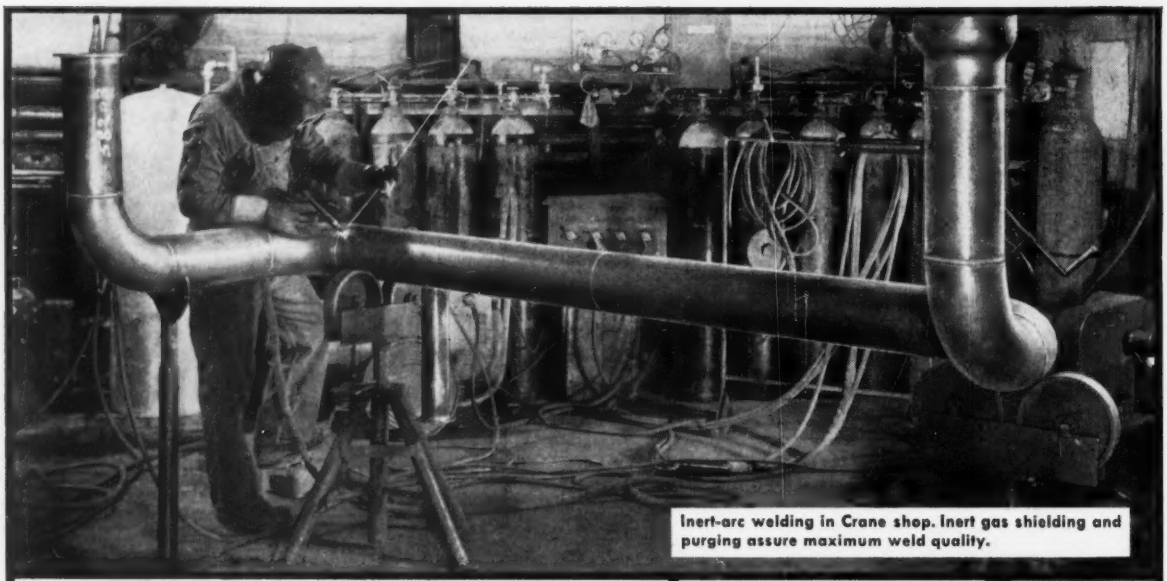
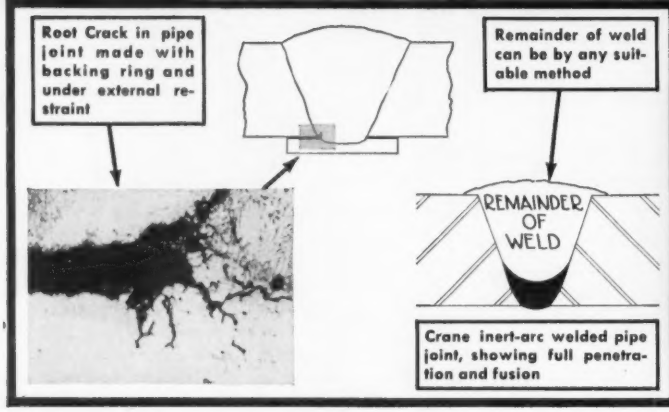
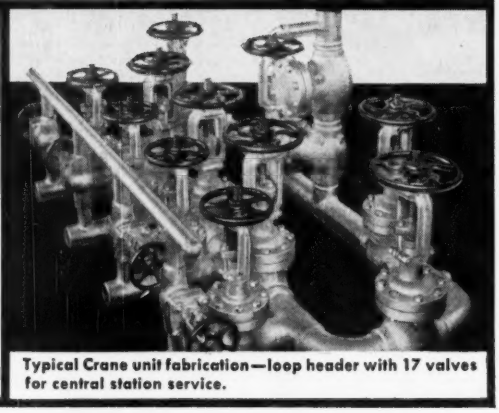


Inert-arc welding in Crane shop. Inert gas shielding and purging assure maximum weld quality.


Root Crack in pipe joint made with backing ring and under external restraint
Remainder of weld can be by any suitable method
REMAINDER OF WELD

Crane inert-arc welded pipe joint, showing full penetration and fusion



Typical Crane unit fabrication—loop header with 17 valves for central station service.

Crane-developed butt-welding technique assures more efficient power piping

Gives important advantages—eliminates backing rings

On shop fabricated assemblies, Crane inert-arc *first pass* welded butt joints are making significant contributions to modern power plant operation.

By eliminating backing rings as used with metal-arc welding, the Crane inert-arc first pass technique assures a high quality weld with smooth root contour without crevices. It eliminates the possibility of basal cracks sometimes associated with backing rings or the characteristics of the base material.

The practicability and dependability of Crane inert-arc *first pass* welding have been thoroughly demonstrated. Leading power plants have been enjoying its advantages for several years, particularly on heavy wall alloy piping for main steam service, and on Schedule 160 carbon steel boiler feed piping.

Welding all types of heavy wall alloy power piping is just one of Crane's services to the power industry. Crane handles every phase of unit fabrication for headers, assemblies and valve groupings—simple or complex, large or small. See your Crane Representative for expert assistance on all power piping needs. Write to address below.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

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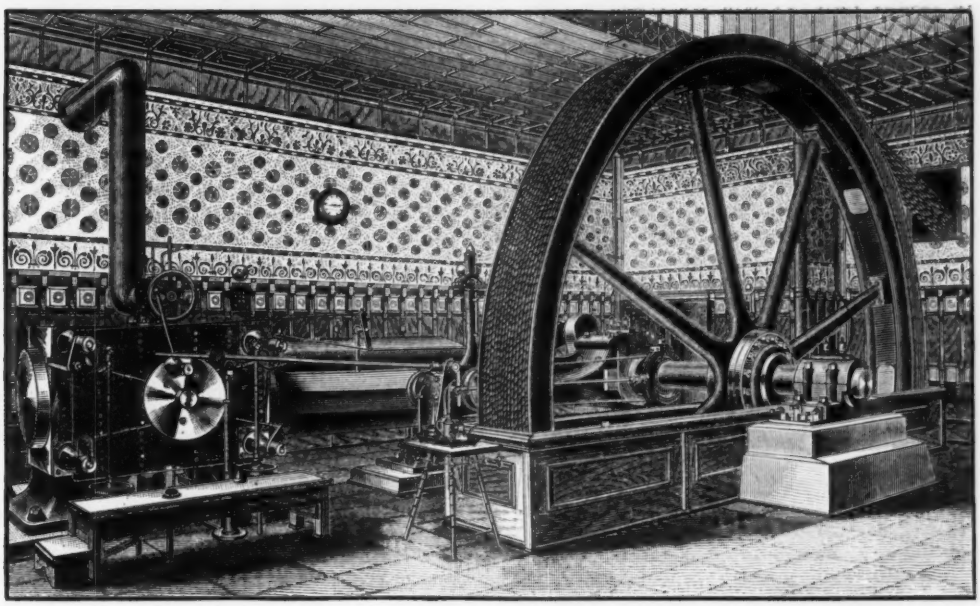
speaking of **Power**



75th Anniversary: Some unforeseen and fascinating digressions

Preparing for our big "75th year" issue in September, we've been searching old copies of POWER for historical milestones. Seems simple enough, but we find ourselves constantly diverted from the main line of research by fascinating items like the picture above. This was particularly interesting because it refers to an old friend, a company then, as now, a progressive leader in its field. The illustration, and the description quoted below, appeared in POWER, April 1892.

"The name of the Dodge Manufacturing Co of Mishawaka, Ind., has long been identified with the wood pulley business, as well as with the system of power transmission by manila rope bearing their name. Some time ago, the company, being compelled to increase their power plant, built a new engine room, and as the latter is said to be the most handsomely fitted-up and decorated engine room in the country, if not in the world, a view of it is given here.

"Main feature of the room, of course, is the engine, a 24x48 corliss made by Lane & Bodley of Cincinnati. The flywheel, 22 ft in diameter, has a wooden rim. As the Dodge works may be called a rope transmission headquarters, this wood rim is grooved, and power is transmitted to the various parts of the works by manila ropes.

"Ceiling and wainscoting of the room are of wood, upwards of 26,000 separate pieces having been used in their construction. These are so fitted that they interlock and are held in place by concealed screws. The material is oak and cherry, finished in white varnish to preserve the natural colors of the wood, and given a piano polish. The plastered portion of the wall is painted in colors to harmonize with the woodwork, and the floor is covered with linoleum. It will take an esthetic engineer to 'live up to' such artistic surroundings!"

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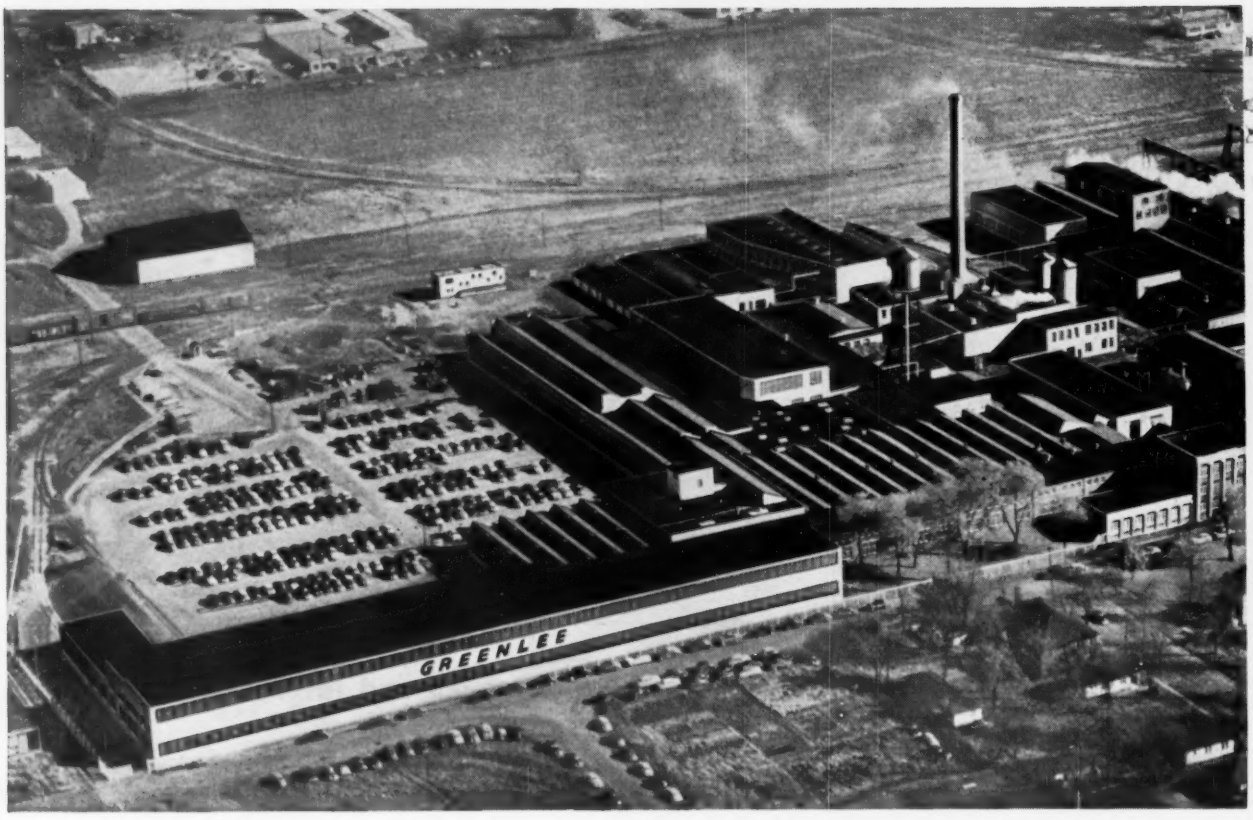


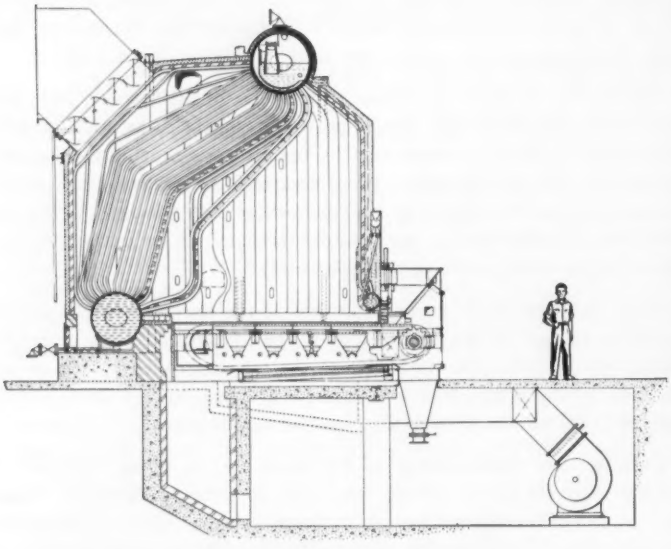
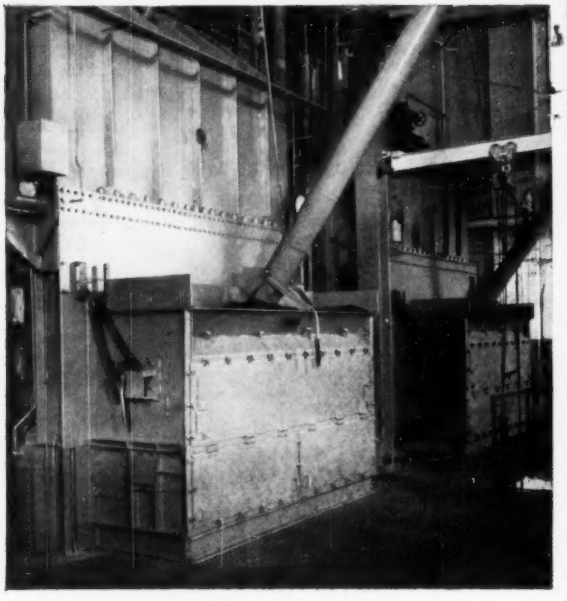


Diagram of B&W Integral-Furnace Boiler with Jet Ignition Stoker. Each unit generates 30,000 lbs of saturated steam per hour at 125 psig.



Two B&W Integral-Furnace Boilers at Greenlee, equipped with B&W Jet Ignition Stokers, burn a wide variety of Illinois bituminous coal.

CUT FUEL COSTS 14%

B&W Boilers with Jet Ignition Stokers assure savings despite increased fuel prices

As one of the country's leading manufacturers of machine tools, Greenlee Bros. & Co., Rockford, Illinois uses large amounts of steam for all year operation of air compressors and for plant heating. And to maintain profitable overall operation it is important that the steam supply be dependable—and steam generating costs kept to the minimum.

Since the installation of two B&W Integral-Furnace Boilers, Greenlee has enjoyed uninterrupted steam service from a dependable, efficient source. Equipped with modern B&W Jet Ignition Stokers, the B&W units have established an outstanding record of operating efficiency while burning a wide variety of Illinois bituminous coal.

At Greenlee, as at other industrial plants using steam, careful consideration of long term costs and proven reliability were important factors in the choice of B&W Integral-Furnace Boiler units.

If your steam production cost is important . . . if you are considering steam plant modernization or expansion for increased dependability and efficiency . . . it will pay you to investigate B&W's more than 90 years of boiler experience. Let us show you what it can do for you. For further information or assistance write to The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-773-1B

HERE'S WHY YOUR STEAM COSTS LESS With B&W Integral-Furnace Units

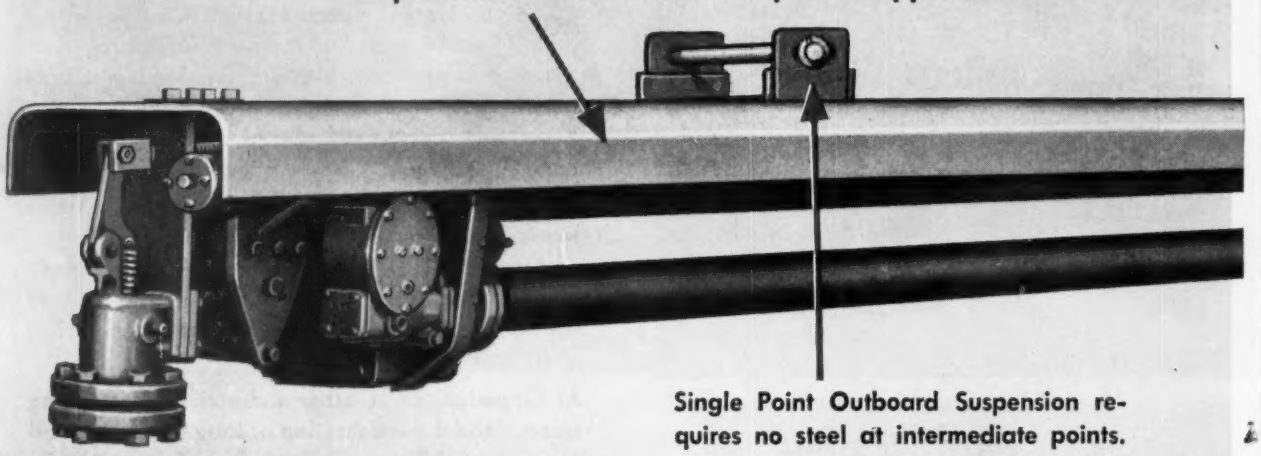
- Minimum floor space and headroom requirements
- High fuel economy
- Smokeless combustion
- Adaptable to all fuels and firing methods
- Economical fast steaming
- Water-cooled furnace
- Clean, dry steam at all ratings, even with high boiler water concentration
- Quick response to wide and heavy load swing demands
- Easy to inspect and clean
- High availability with least attention

BABCOCK & WILCOX

BOILER DIVISION

Backbone and Protective Cover

Top Cover is an integral part of the structural "Backbone" of the blower unit that assures greater rigidity. It also provides protection from dirt, damage, the elements, and personnel hazard . . . with improved appearance.



Single Point Outboard Suspension requires no steel at intermediate points.

One of the most popular features of the new Diamond Series 300 IK Long Retracting Blower is the very substantial cover that is formed from steel plate. It is much more than just a cover in the ordinary sense . . . it is also an integral part of the structural backbone of the blower that provides maximum rigidity without excessive weight.

This is only one of many important features (see box on right hand page) of the new Series 300 IK that is establishing a new standard of efficiency, economy and dependability in cleaning those heating surfaces that require a long retracting blower. For further information about the new Series 300 IK, ask the nearest Diamond office for Bulletin 2111U.

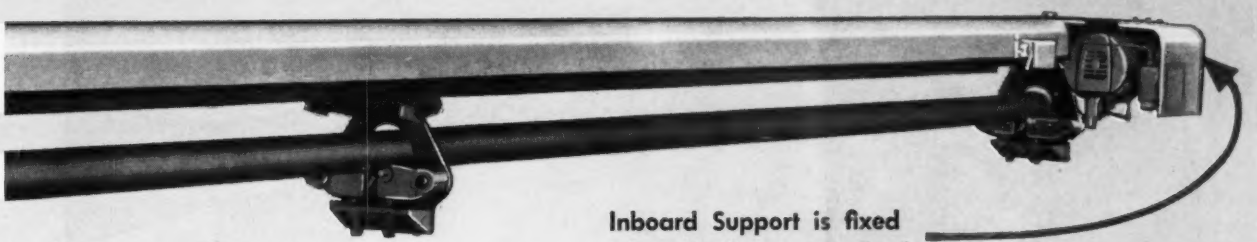
Diamond

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

Diamond Specialty Limited • Windsor, Ontario

ANOTHER IMPORTANT FEATURE of the NEW Diamond SERIES 300 IK LONG RETRACTING BLOWER



Inboard Support is fixed or from boiler, as required.

"YOU CLEAN BOILERS BETTER AND AT LOWER COST WITH DIAMOND BLOWERS"

OTHER ADVANTAGES OF SERIES 300 IK BLOWERS

- Front End Single-Motor Drive
- Compact, Accessible Electric or Air Power and Control Terminal Facilities
- Nozzle-Sweep-Every-Inch Cleaning Pattern
- Improved "Type A" Nozzle
- Positive Gear Carriage Drive
- Poppet Valve with Adjustable Pressure Control
- Positive Mechanically Operated Valve
- Single Point Outboard Suspension
- Oversize Lance (Step-Tapered for Extra Long Travel)
- Auxiliary Carriages for Extra Long Travel
- Designed for Quick, Easy Servicing

No other blower gives you all these advantages.

7697

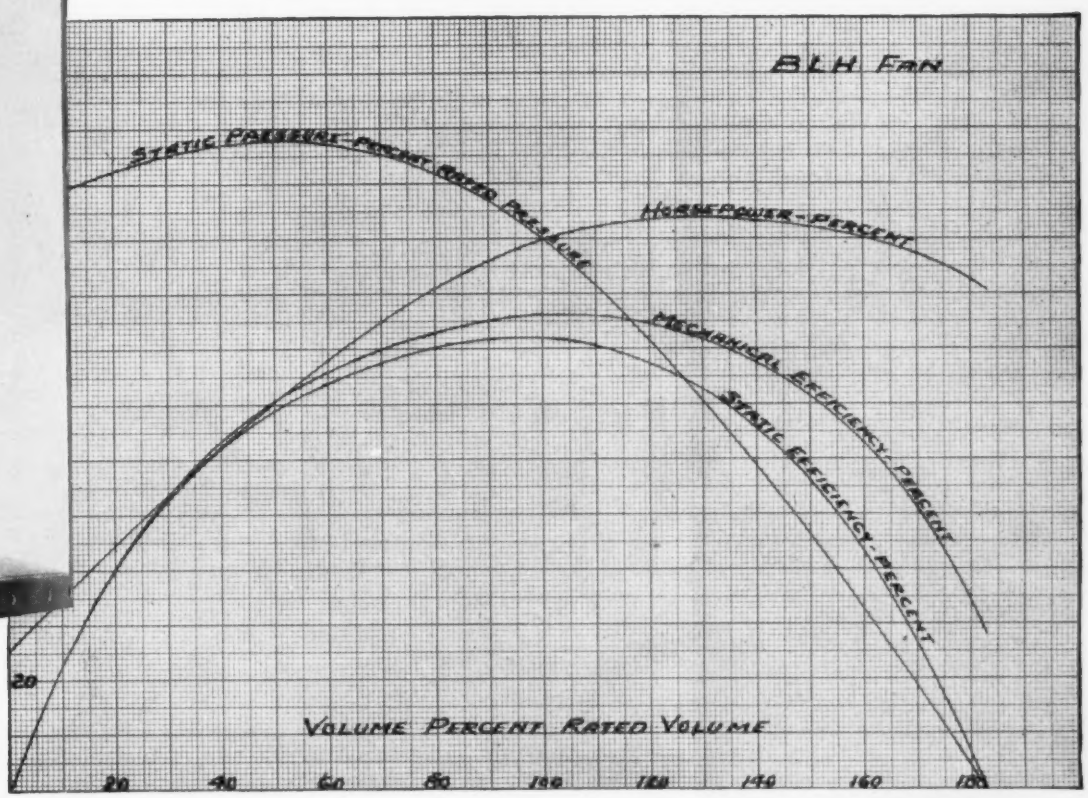
A NEW HIGH IN

"Buffalo" Type BLH Fan for high pressure air moving. Its efficiency is due to advanced rotor, inlet and outlet features developed exclusively by "Buffalo".

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT

FORCED DRAFT EFFICIENCY OVER THIS BROAD RANGE!

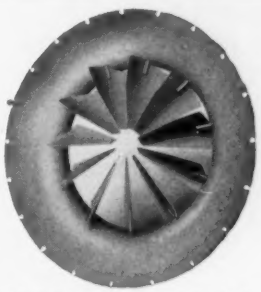
"BUFFALO" TYPE BLH FAN FOR CLASSES II, III AND IV



If peak efficiency, along with durability and servicability, are important to you in a forced draft fan, the BLH deserves your closest investigation.

Note the broad curve of mechanical efficiency above — 80% or better from 65% to 135% of rated volume — permitting flexibility of operation. This performance has been achieved through inlet-to-outlet streamlining — a smooth inlet bell, cantilevered inlet vanes, backward curve blades, specially curved rotor flange and divergent outlet — minimizing turbulence at every point to give air the smoothest ride ever. And the new "Buffalo" Variable Inlet Vanes can be substituted for the stationary inlet vanes for smooth draft control with no performance loss in open position.

The BLH is one of a complete *series* of "Buffalo" Draft Fans available to meet your draft requirements exactly, with no guess work and no compromise. Write for Bulletin F-200 and recommendations on your problem.



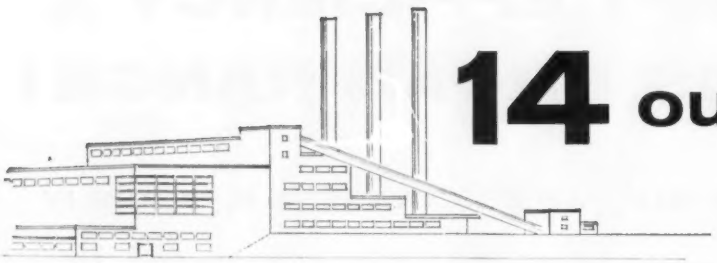
"Buffalo" Cantilevered Variable Inlet Vanes have no center ring to cause entry loss, and the control mechanism is out of the air stream, assuring smooth volume control without sacrificing fan performance.

BUFFALO FORGE COMPANY

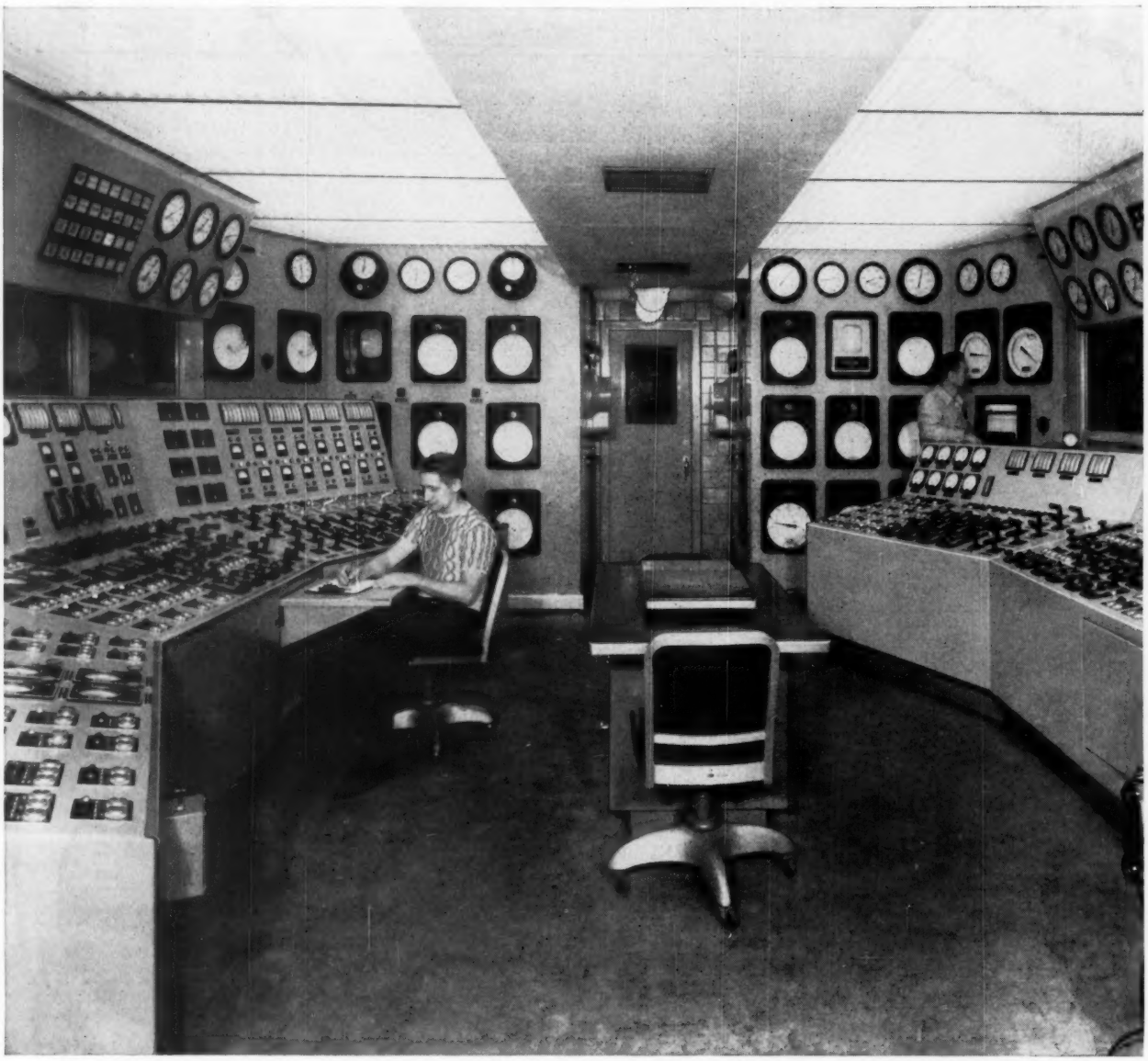
BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

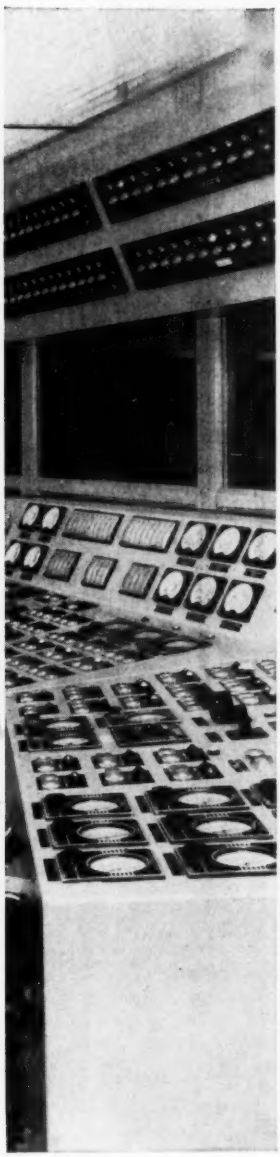


14 out of the 15



The steam control room for units 3 and 4 of the Eastlake Plant of The Cleveland Electric Illuminating Company. Eastlake uses Bailey Meters and Bailey Controls for Combustion, Feed Water and Steam Temperature. The FPC reported a 1955 heat rate at Eastlake of 9,336 Btu per kwhr, making it the seventh most efficient plant in the United States.

"most efficient*" plants use Bailey Meters and Controls



How's that for a vote of confidence! In the electric power industry, quality and dependability of equipment are paramount and 14 out of the top 15 power stations on the FPC's 1955 list chose Bailey Meters and Controls. Nine of these 15 chose Bailey equipment exclusively!

For breadth of product line, depth of experience, size and quality of field service organization, no one offers more to the power industry than Bailey. And the time to contact Bailey is during the early planning stage, when our recommendations can save time, trouble and money. Our engineers are at your service.

* 15 MOST EFFICIENT PLANTS

1955 Heat Rates Reported by FPC

	Btu/kwhr	Meters	Comb. Cont.	Feed Water Cont.	Steam Temp. Cont.
1. Kyger Creek (Ohio Valley Electric Corp.)	9,110	B		B	B
2. Clifty Creek (Indiana-Kentucky Electric Corp.)	9,143	B	B	B	B
3. Kanawha River (Appalachian Electric Power)	9,151	B	B	B	B
4. St. Clair (Detroit Edison Co.)	9,220	B	B	B	B
5. Muskingum River (Ohio Power Co.)	9,234	B	B	B	B
6. Tanners Creek (Indiana & Michigan Electric Co.)	9,273	B	B	B	B
7. Eastlake (Cleveland Electric Illuminating Co.)	9,336	B	B	B	B
8. Philip Sporn (Ohio Power Co.)	9,341	B	B	B	B
9. Shawville (Pennsylvania Electric Co.)	9,368	B			B
10. Albany (Niagara Mohawk Power Corp.)	9,373				
11. El Segundo (Southern California Edison Co.)	9,417	B	B	B	B
12. Oak Creek (Wisconsin Electric Power Co.)	9,480	B	B	B	B
13. Kearney "B" (Public Service Electric & Gas Co.)	9,511	B		B	B
14. Dunkirk (Niagara Mohawk Power Corp.)	9,523	B	B	B	
15. Cromby (Philadelphia Electric Co.)	9,540	B		B	B

B — Bailey installation

A130-2

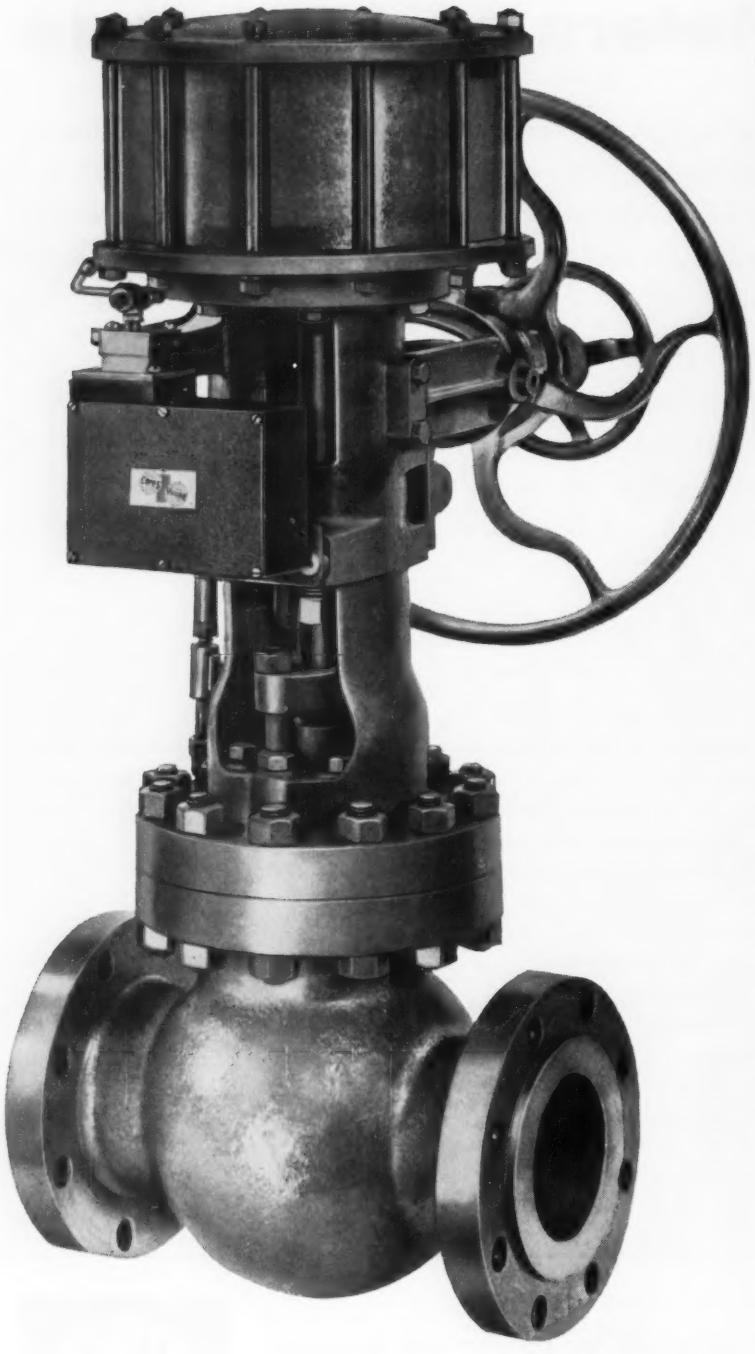
Instruments and controls for power and process

BAILEY METER COMPANY

1036 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

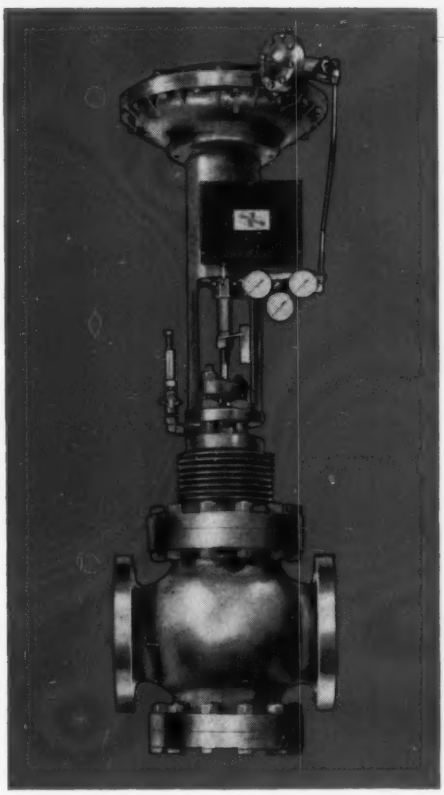


NOW

Piston-Type CV-P. For high-duty service. Extremely precise positioning gives you superb operating characteristics. Rangeability is high. Response can be characterized to meet your operating requirements. Designed for those applications which demand the ultimate in valve-operating force . . . where you want the finest valve money can buy. Hand wheel is optional.

Diaphragm-Type CV-D. Either direct or reverse acting. High rangeability. Optional features include: Cooling fins and lubricator for stuffing box that will maintain low friction over longer packing life; hand wheel for emergency operation.

the right valve for more jobs!

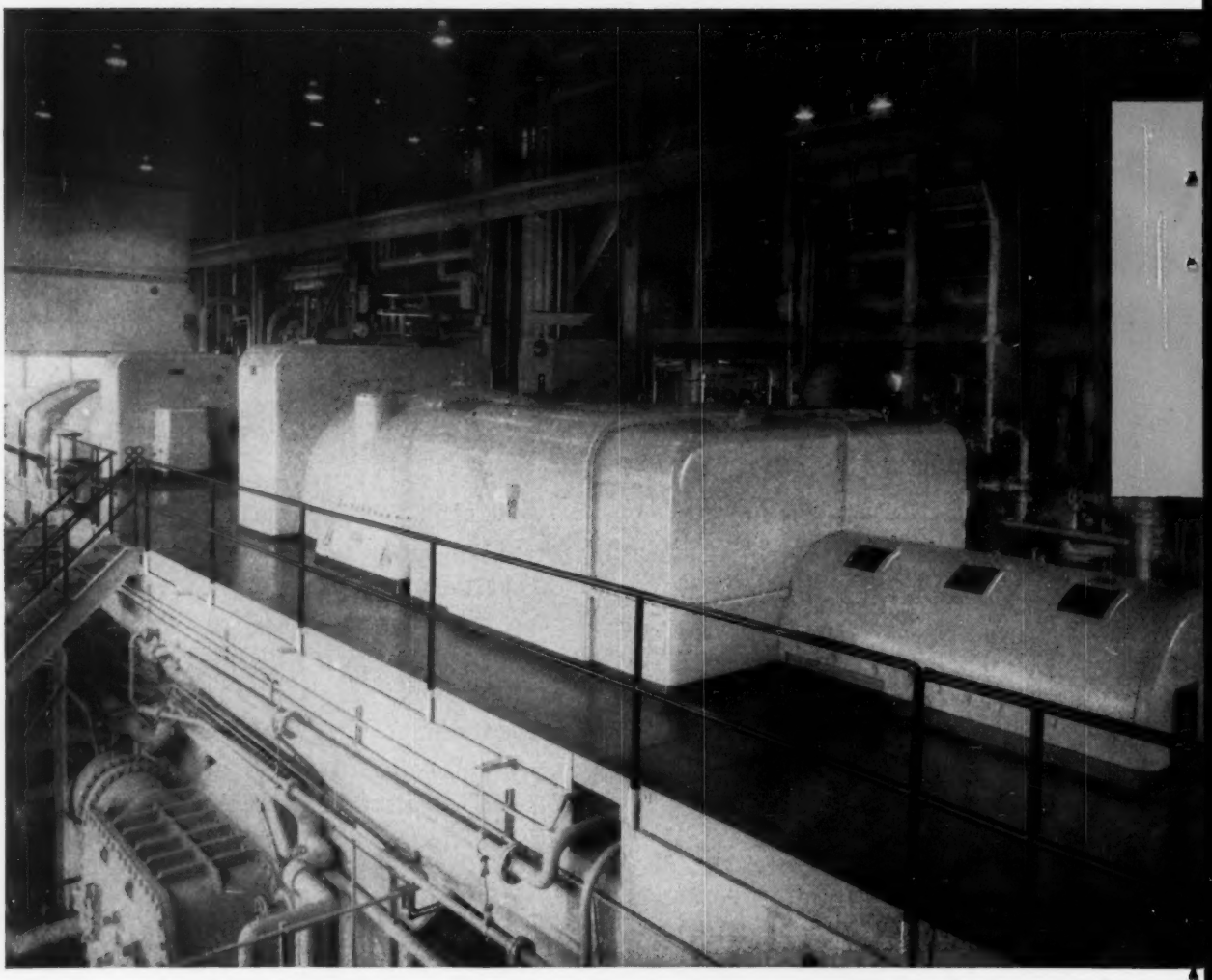


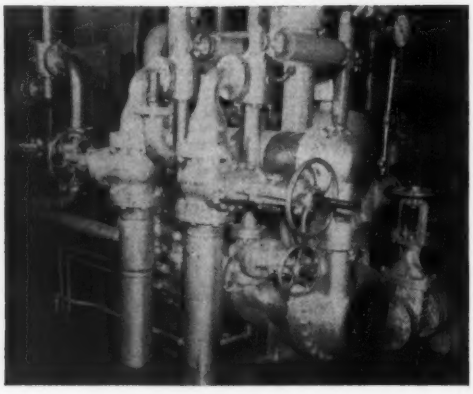
Now you can apply high-quality Copes-Vulcan Valves to any application, at unlimited pressures in sizes up to 12 inches. Simplified design gives you this new versatility, plus high standards of performance for broader applications. Too, you will get the Copes-Vulcan custom-design, with ports exactly suited to the requirements of your operation.

Get in touch with your Copes-Vulcan man. He can help you apply the new Copes-Vulcan Valves to your control requirements. You'll get real dollars-and-cents savings in operational cost with less downtime in even those troublesome spots where ordinary valves are inadequate. Write for Bulletin 1027.

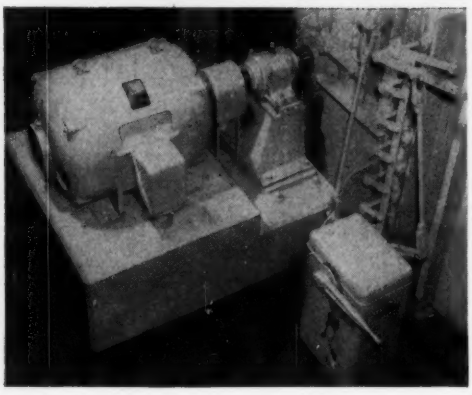
COPES-VULCAN DIVISION
BLAW-KNOX COMPANY
ERIE 4, PENNSYLVANIA

50th Anniversary
BLAW-KNOX
1906-1956





An Elliott twin two-stage steam jet ejector serves the condenser. Ejector is equipped with air leakage meter.



The forced-draft fan is driven by an Elliott C-W 150-hp, 1160-rpm motor.

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS
CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

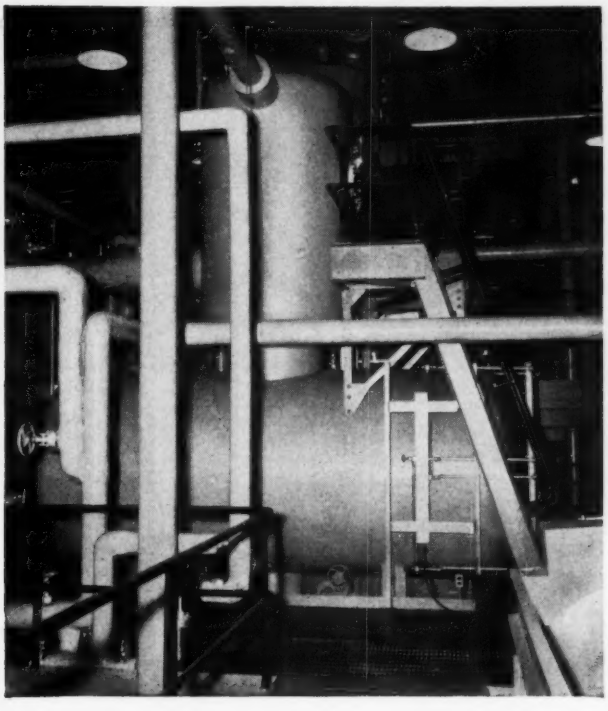
08-3

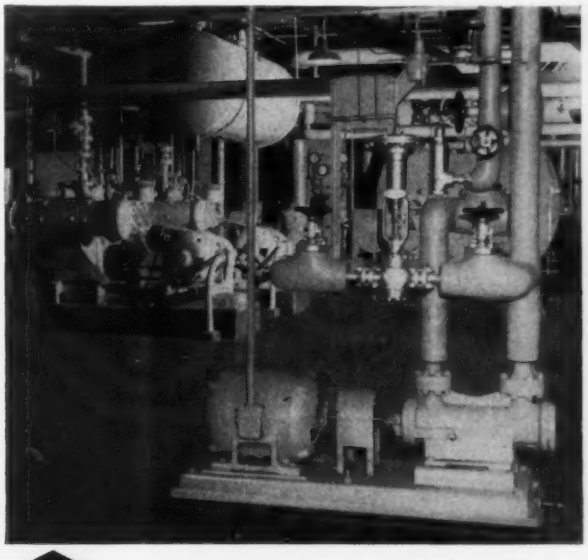
SECOND ELLIOTT UNIT installed at CARIBOU . . .

When Maine Public Service Company decided to expand the generating facilities of their Caribou Power Center, they had the benefit of four years of experience with Elliott equipment to guide them in the selection of turbine generator, condenser and auxiliaries for Unit No. 2. The equipment shown on these pages is all installed in Unit No. 2, and is evidence of the satisfactory performance of the Elliott machines in Unit No. 1.

Complete information on Elliott equipment may be obtained from our nearest District Office, or from Elliott Company, Jeannette, Pa.

This view of the turbine room shows in the foreground the No. 2 12,650-kw Elliott turbine-generator unit. Underneath it may be seen the Elliott 11,000-sq-ft surface condenser serving this turbine. Ejectors are behind the generator. In the left background is the 7500-kw Elliott turbine-generator unit installed in 1950.

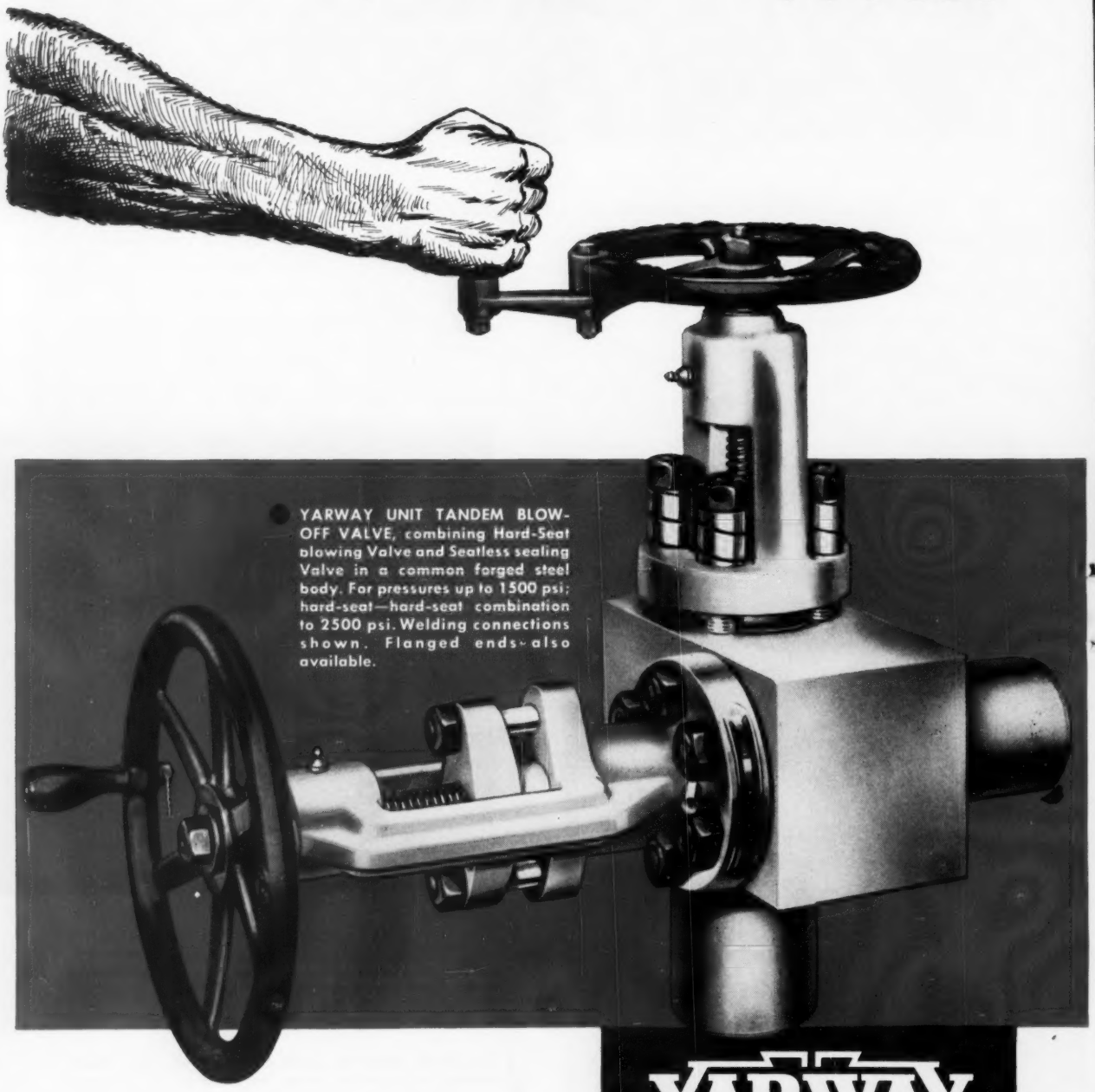




The photograph above shows two air compressors driven by Elliott C-W 75-hp, 1765-rpm motors. In the foreground, the fuel oil booster pump is driven by a 15-hp, 740-rpm motor. Condenser is seen in the background.

The Elliott 128,010 lb-per-hr deaerating feedwater heater consists of a vertical heater mounted on a horizontal storage tank. It is located at an elevation near similar No. 1 unit.

rugged ... for



YARWAY UNIT TANDEM BLOW-OFF VALVE, combining Hard-Seat blowing Valve and Seatless sealing Valve in a common forged steel body. For pressures up to 1500 psi; hard-seat—hard-seat combination to 2500 psi. Welding connections shown. Flanged ends also available.

YARWAY

rugged blow-down service

YARWAY UNIT TANDEM BLOW-OFF VALVES

When boiler pressures are high you may not "blow-down" very often, but, man, when you do, you're glad those blow-off valves are rugged YARWAY Unit Tandems!

More than 80% of high pressure boiler plants are equipped with YARWAY *Blow-Off Valves,* and there's ample reason.

YARWAYS are strong, heavy-duty valves giving the important extra dependability needed for the severe combination of high pressures (hence high velocities), acid cleaning, and abrasion caused by precipitated solids.

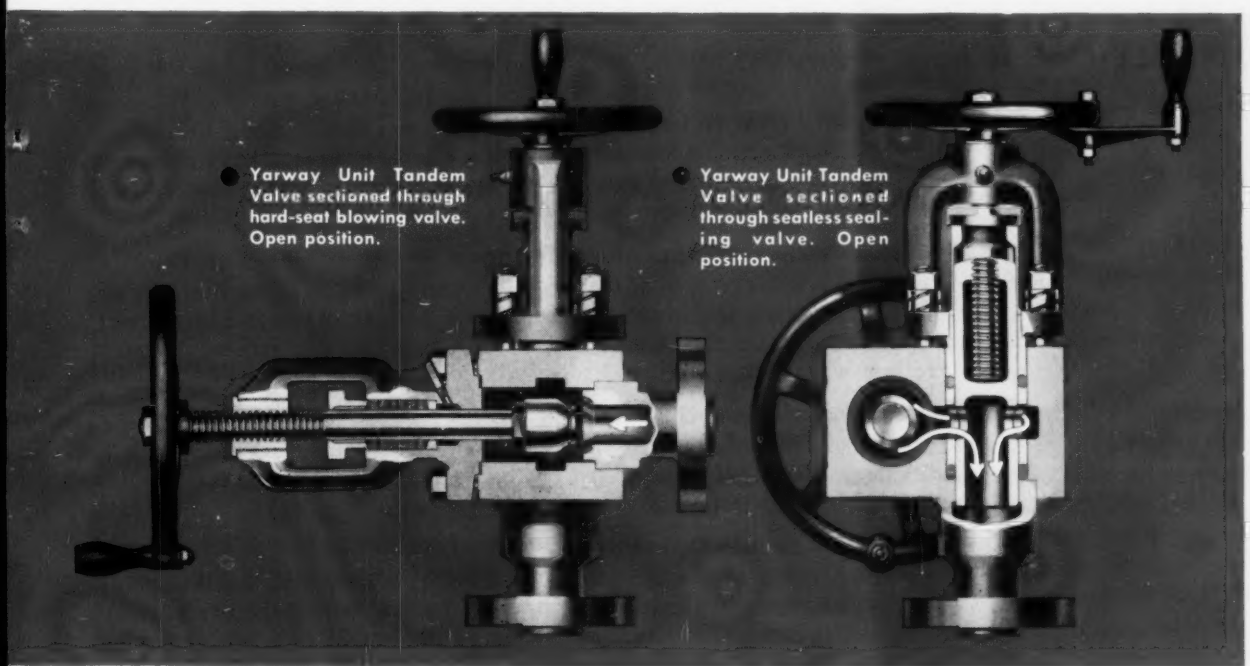
YARWAY Blow-Off Valves also are relied upon to keep boiler level within desirable limits during quick starts of high pressure boilers.

Specify YARWAYS—to protect *your* boilers. Write for Bulletin B-434.

YARNALL-WARING COMPANY

100 Mermaid Ave., Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES



● Yarway Unit Tandem Valve sectioned through hard-seat blowing valve. Open position.

● Yarway Unit Tandem Valve sectioned through seatless sealing valve. Open position.

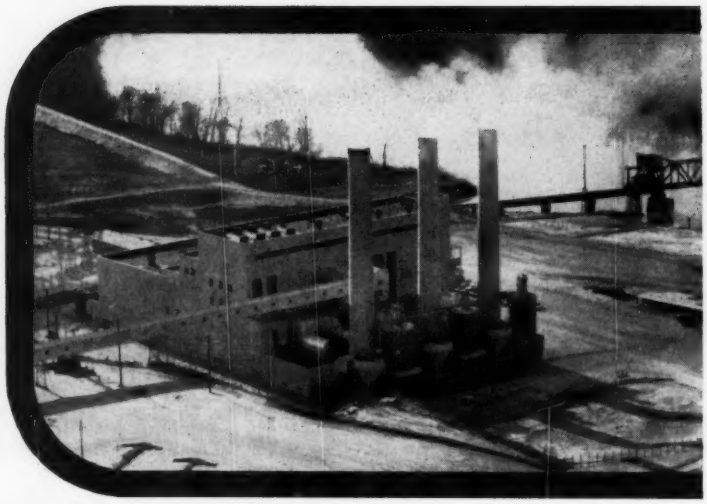
— blow-off valves

South Carolina Generating Company's

(Wholly-owned Subsidiary of South Carolina Electric & Gas Co.)

URQUHART STATION

UNIT No. 3



where . . . REPUBLIC *Automatic* COMBUSTION CONTROLS *Anticipate* FUEL-AIR-WATER REQUIREMENTS!

BRIEFLY—this is how it works:

Controls Respond First to Load Changes

REPUBLIC "Electronic Master" combustion control first detects any change in steam flow and immediately transmits a signal proportional to that change to the combustion air, coal pulverizers and/or gas valve, and feedwater valve.

Curb Pressure-Water-Temperature Changes

Corrective settings of each of these controls starts *with* the steam flow change and follows the change closely; this keeps steam, fuel, air, water and (of course) flue gas flows in the closest possible balance, minimizing fluctuations of header pressure, drum water level, and superheater outlet temperature.

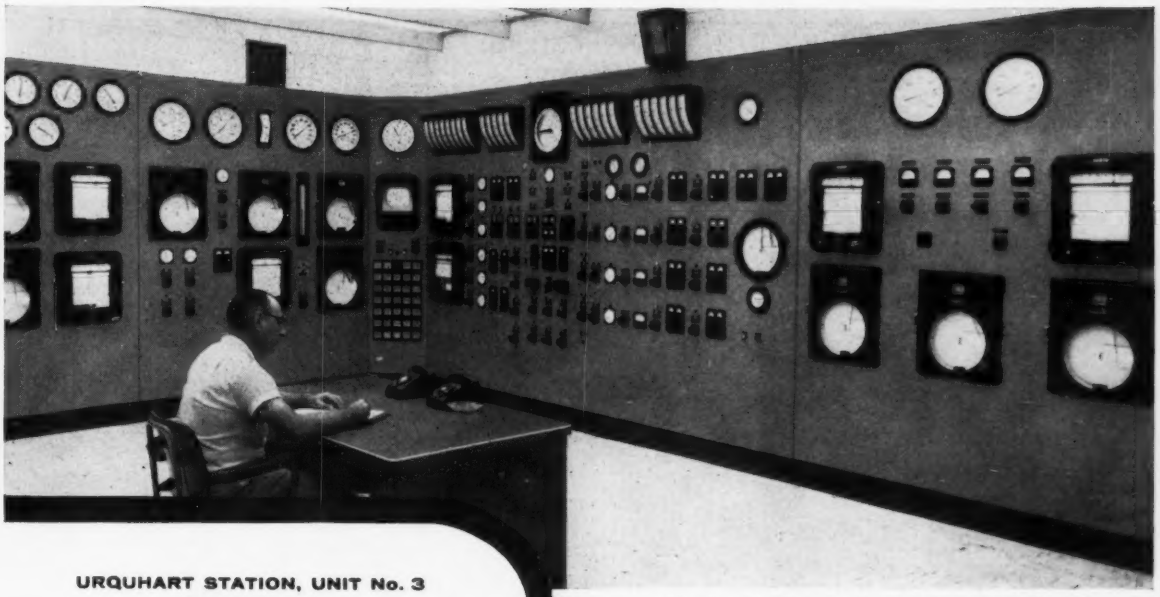
Pressure Controls Follow Up

Any slight change of header pressure or drum level that *does* occur is immediately detected and fed to the proper control as a modulating signal that restores complete balance . . . quickly.

Combined Fuels—Stable Operation

This combination of flow-initiated and follow-up adjustments, with electronic control and pneumatic drive units, means top-notch stability, accuracy, sensitivity and reliability for Urquhart Station's Unit No. 3, even while burning combined fuels!

REPUBLIC FLOW METERS CO.



URQUHART STATION, UNIT No. 3
STEAM DATA:

Rated Capacity 700,000 LB/HR ——— 1825 PSI
SUPERHEAT 1010 F —— REHEAT 1010 F
FUEL: PULVERIZED COAL AND/OR GAS
COMBUSTION CONTROL:
REPUBLIC Automatic ELECTRONIC

Urquhart No. 3's control room where automatic and remote-manual controls are centralized.

Planned expansion of power for the great Southeastern United States is typified by the latest addition to Urquhart Station of the South Carolina Generating Co. Planned by Gilbert Associates, Unit No. 3 is modern today and will be modern tomorrow —*and will be considered "modern" by performance as well as appearance standards.*

REPUBLIC's "Electronic Master" combustion control is a logical partner in such advanced thinking. The quick, long arm of electronic control plus reliable, powerful actuation by pneumatics gives Urquhart No. 3 the reflexes it needs to meet any operating crisis and hold single—or combined—fuel consumption low. For greatest speed of control, REPUBLIC has provided a load-responsive system that regulates all combustion factors *before* pressure drops or jumps occur. Any pressure fluctuations following this advance adjustment are very limited and are promptly compensated by a pressure control system that modulates the fuel and air control signals.

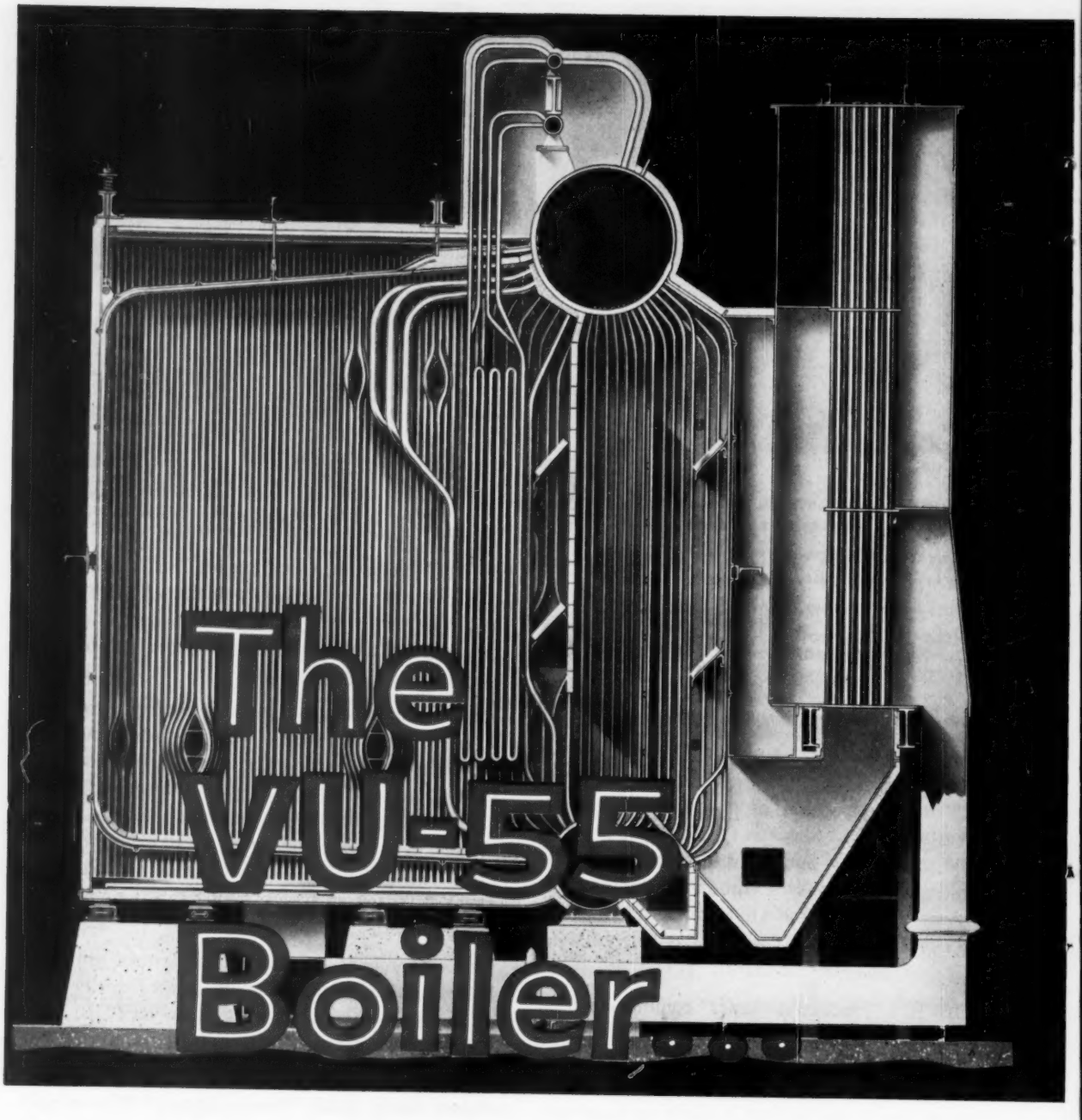
REPUBLIC's three element feedwater regulator adjusts feedwater flow in proportion to steam flow, and follows up this action with a correction for drum level. Total level fluctuations are thereby held to a strict minimum.

Remote manual operation of any or all control units is possible at any time. The operator need only throw the transfer switch on his panel and take over; indicators at the operating station show electronic loadings to the regulators and positioners, and show the rate of response and position. All electronic amplifiers have built-in surplus capacity for extra life and special design features for quick maintenance when needed.

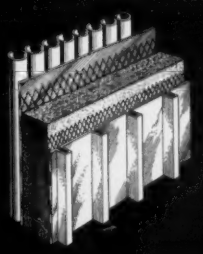
This comprehensive treatment of control problems is typical of REPUBLIC engineering. Equally thorough follow-up and servicing make REPUBLIC a helpful partner in new or modernized power operations—of any size.

Need Help With "Early Stage" Planning? If you are planning ahead for new conventional or "unconventional" facilities, remember that REPUBLIC, too, is planning ahead. For help in projecting your new facilities in terms of new control, metering and recording equipment—and the latest in top quality valves—contact REPUBLIC's Engineering Department as soon as this help can be beneficial.

2240 Diversey Pkwy., Chicago 47, Illinois



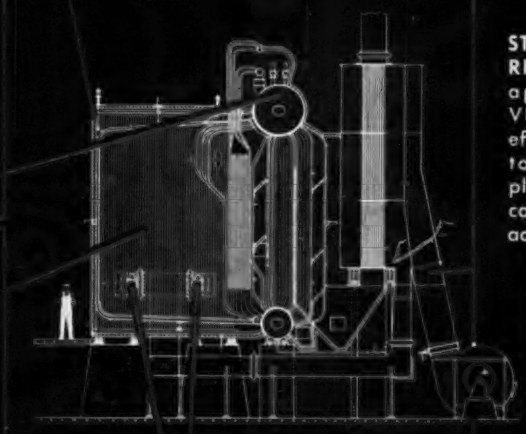
Custom Features, Standard Sizes, Advanced Design



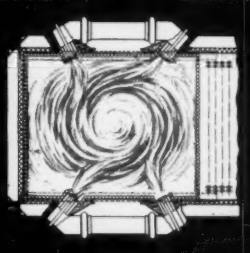
DOUBLE WALL, PRESSURE-TIGHT CASING. The latest development in casing construction for pressure firing of boilers in the size class of the VU-55, this casing is designed to assure life-time tightness with minimum heat loss. Pressure firing permits the elimination of an induced draft fan with its attendant operating and maintenance costs. Construction consists of tangent tubes backed up successively by welded steel panels, 4 inches of high quality insulating material and an outer steel casing formed as shown to provide adequately for expansion and assure ample strength. Low heat loss and the tightness required for pressure firing are assured by this double-wall construction.

HIGH STEAM QUALITY. Equipped with a large (60-in.) steam drum, the VU-55 has generous water capacity and steam reservoir space. C-E drum internals assure high quality steam at all ratings.

TANGENT FURNACE TUBES. The VU-55's furnace tube arrangement provides complete heat-absorbing, water-cooled protection on all furnace walls. Furnace maintenance is minimized, refractory expense is eliminated, heat absorption rates per sq. ft. are higher.



STREAMLINED EXTERIOR. The over-all appearance of the VU-55 reflects the efforts of its designers to achieve a completely unobstructed casing, while retaining adequate access wherever required and every facility for convenient operation. There are no outside downcomer tubes, and the ducts from air heater to burners are beneath the furnace floor.



TANGENTIAL FIRING. More than 20 years of application experience have established the exceptional advantages of tangential firing. About 90 percent of Combustion's large utility installations use this advanced method of firing. Flame streams from the four burners impinge upon one another at high velocity, as shown, creating a turbulence unattainable by any other method of firing. The result is rapid and complete combustion. As the gases spiral upward, they sweep all furnace heating surfaces, assuring a high rate of heat absorption.

The VU-55, newest of the C-E line of Vertical Unit Boilers, represents the closest approach to central station performance yet achieved in standardized boilers in its capacity range.

Its design combines a number of time-tested and service-proved features, such as Tangential Burners, double wall, pressure-tight casing, and tangent furnace tubes. In addition, this bottom-supported unit requires no outside supporting steel, is economical of space and streamlined in appearance.

It is available in 5 sizes for capacities from 50,000 to 120,000 lb per hour. It is designed for 3 pressure ranges (250, 500 and 750 psi) and can be equipped with a superheater to provide temperatures up to 750 F. Either a tubular or a regenerative air heater is available.

The VU-55 Boiler is symmetrical in design, performs efficiently over a wide range of output, and is easy to operate and maintain.

It is, in fact, the boiler with the custom features and the advanced design.

COMBUSTION ENGINEERING

CE

B-978

Combustion Engineering Building

200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd.

all types of steam generating, fuel burning and related equipment; nuclear reactors; paper mill equipment; pulverizers; flash drying systems; pressure vessels; soil pipe.

Revolutionary Performance!

Riley Boiler Unit gives bonus of 20,000 pounds per hour of steam to Masonite Corporation

Here's the maximum capacity guaranteed to Masonite by Riley Stoker Corporation:

50,000 lb. continuous
60,000 lb. for 15 min. peaks

And here's the Masonite report on performance: "For the past 75 days the average hourly load on the new boiler has been 70,000 pounds with peaks of one and more hours' duration of 75,000 pounds."

This same installation called for a guaranteed air heater gas temperature not in excess of 395 degrees at 50,000 pounds of steam per hour. In actual operation at 54,500 pounds of steam per hour, the air heater exit gas temperature was only 377.5 degrees!

No wonder Riley Stoker Corporation, Worcester, Massachusetts, is so well known among leading plants throughout the nation for the highly efficient performance of its boilers!

Coppus-Dennis FANMIX Burners Were Installed

To assure such revolutionary performance, Riley specified Coppus-Dennis FANMIX Burners for its boilers. The exclusive FANMIX action — on *all* Coppus burners, gas as well as combination gas-oil — is the reason for such performances.

FANMIX : Better Combustion : Better Efficiency : Higher Ratings

FANMIX burners, with their *revolving orifices*, give violent mechanical mixing and agitation of gas and air and, therefore, instantaneous and complete combustion with *minimum excess air* (5% excess air not unusual).

Furnace space is not required for mixing; therefore, *higher boiler ratings* are easily obtained.

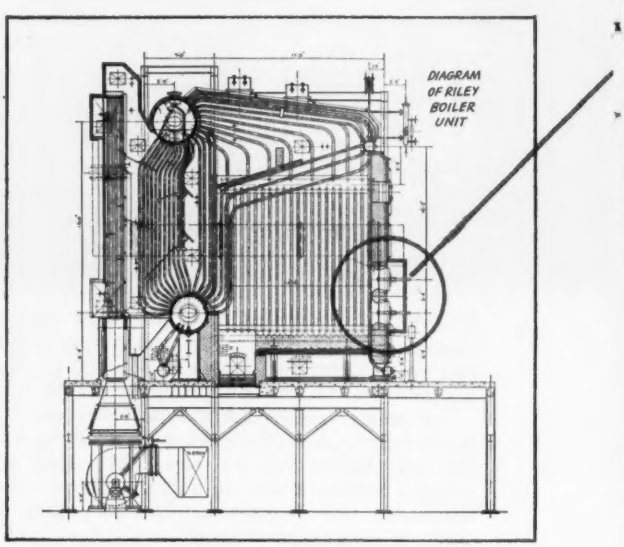
FANMIX burners, with shorter flame than any other burner, cannot cause flame impingement.

FANMIX burners, incorporating a *fan* as an integral unit, have *no draft loss* across the burner. Therefore, regardless of draft conditions, increased ratings are possible.

FANMIX action, with its quick completion of combustion, gives *lower* exit gas temperatures.

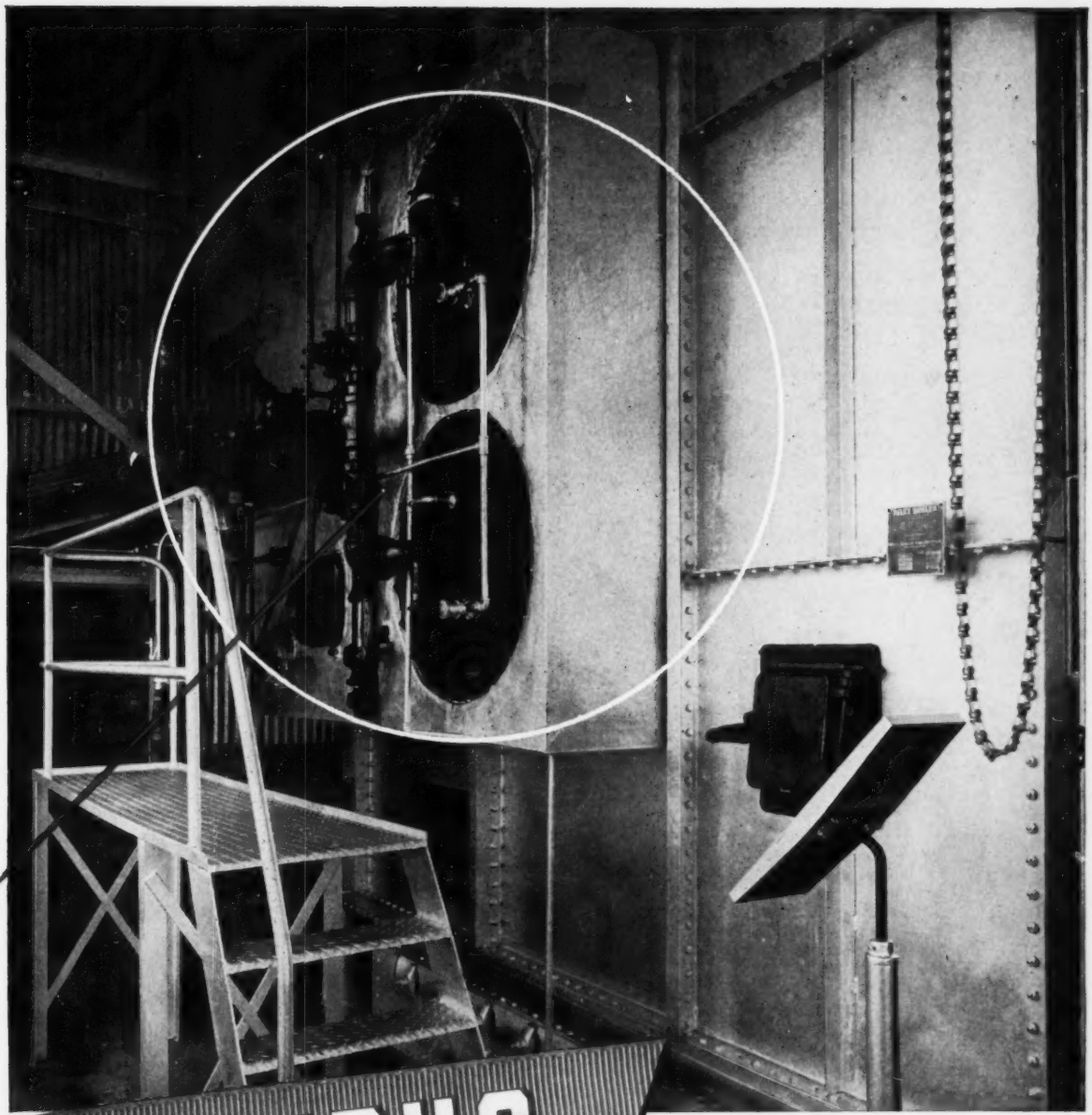
Plan now to take advantage of Coppus-Dennis FANMIX action with your present boiler. Remember — no forced draft equipment nor increase in stack nor increase in furnace volume is required for *FANMIX* operation to get increased capacity. And on *new* boilers, FANMIX lets you plan on reduced combustion space, higher ratings, less stack height or reduced induced draft capacity, and *no* forced draft equipment. Mail coupon today. Sales offices in *Thomas' Register*. Other "Blue Ribbon" Products in *Chemical Engineering Catalog, Refinery Catalog, Best's Safety Directory, and Mining Catalogs.*

JET REACTION is utilized to rotate fan which is integral part of burner. Automatically proportioned high velocity air passes at right angles through fuel to create ideal mixture for fast, complete combustion and peak efficiency.



Well-Known Users of Riley Units with FANMIX Burners Include:

Publicker Commercial Alcohol Co.
Monsanto Chemical Co.
Gaylord Container Corp.
Commercial Solvents Corp.
Celanese Corp. of America
Gulf Power Co.
Mississippi Power Co.
Eagle-Picher Lead Co.
Humble Oil & Refining Co.
Godchaux Sugars, Inc.
Kennecott Copper Corp.
Nicholson File Co.
Bird & Son, Inc.
— and many others



COPPUS

FANMIX® BURNER

GAS . . . COMBINATION GAS-OIL

RILEY BOILER UNIT, using FANMIX burners, is here shown as installed for the Masonite Corporation, Laurel, Mississippi. Circle in diagram at left indicates position of burners pictured above.

SEND COUPON for further information. Coppus engineers FANMIX burners to your individual requirements.

PLEASE ATTACH THIS COUPON TO YOUR COMPANY LETTERHEAD

COPPUS ENGINEERING CORPORATION
162 Park Avenue
Worcester 2, Massachusetts

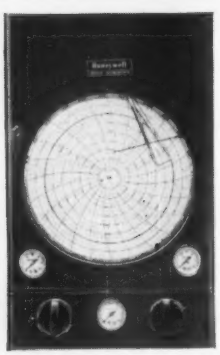
Please send complete data on Coppus-Dennis FANMIX Burners. I'm particularly interested in
☐ gas ☐ combination gas-oil.

Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....



Simplicity . . . Versatility, Too

A wide variety of models, ranges and accessories are available for exact matching of Brown thermometers and pressure gages to your specific applications.

Simplicity...

you'll find it in Brown thermometers and pressure gages

CLEAN, SIMPLE DESIGN—simplicity that minimizes operating or maintenance difficulties—sets Brown thermometers and pressure gages apart. Using direct, simple linkages, these rugged instruments have few elements. Basic components for both thermometers and pressure gages are interchangeable, and cases are identical. Maintenance is easy and your spare parts requirements are reduced. This is simplicity that will pay off in many years of reliable, economical service.

And with this simplicity comes dependable, high accuracy. The many narrow spans available, together with the large charts and scales, give you the full use of this accuracy.

Brown thermometers are particularly suitable for the intermediate temperature range, extending from —125 to 1000 F. Brown pressure gages are available in many ranges, with a minimum of absolute zero and a maximum of 4,000 psi.

Your nearby Honeywell sales engineer will gladly give you complete details on these instruments as they relate to your particular requirements. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

Cleveland Electric generates more power, more efficiently

Worthington heat and fluid transfer equipment helps Eastlake Station attain efficiency of ¾ lb of coal/kwhr

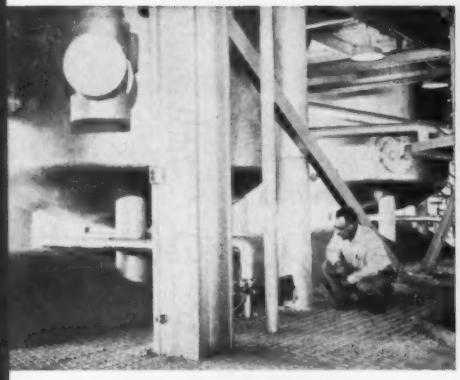
To a large extent good heat rate in any power plant is determined in three important places . . . in the boiler room where steam is produced, in the turbine room where electricity is generated, and in the heat and fluid transfer section of the plant where the condenser, its auxiliaries, and the boiler feed pumps play an important part in controlling plant heat balance. It's a fact that efficiency depends as much on all this latter equipment as on the rest of the plant.

That's why in designing their new 660,000 kw Eastlake plant, Cleveland Electric Illuminating engineers spent hundreds of hours studying various system arrangements. For all four generating units the condensers, deaerators, boiler feed pumps, vacuum pumps, and other miscellaneous auxiliaries were supplied by Worthington who offered coordinated design, engineering and manufacturing on these products. This careful study contributed greatly to the achievement of one of the most efficient and modern steam power plants in operation today.

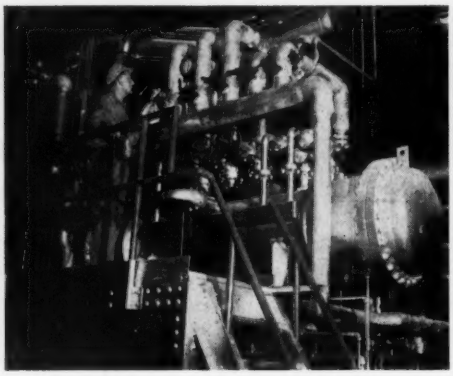
This "system wise" experience has been responsible for many Worthington steam power equipment advances such as high speed boiler feed pumps running up to 9,000 rpm; full contact deaerators which need practically no maintenance because they do away with the vent condenser; and "Double Folded Tube Layer" condensers which can be "tailored" to available space.

We'd like to put this experience to work for you. Just get in touch with us at your nearest Worthington District Office. Or write to Worthington Corporation, Steam Power Dept., Harrison, New Jersey. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ontario. S64

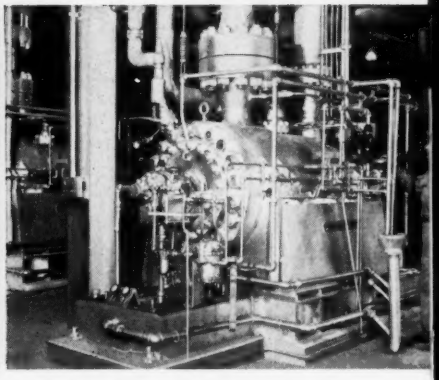
WORTHINGTON



Deaerators. This 1,515,000 lb./hr. unit at Eastlake consists of two vertical shells mounted on horizontal storage tank.

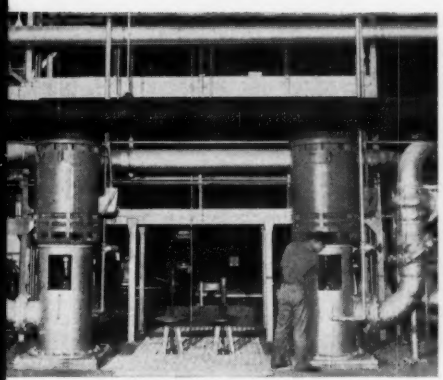


Ejectors and Vacuum Pumps. One of four steam-jet air ejectors serving condensers at Eastlake.

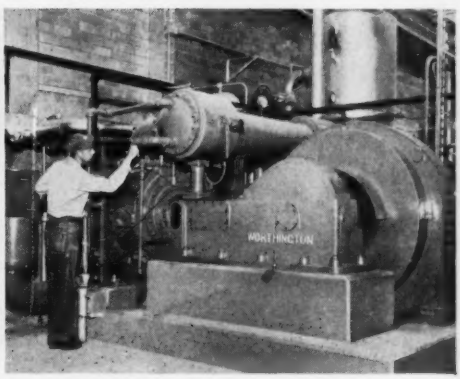


Boiler Feed Pumps. Operating at 3,050 psi, three 9-stage pumps supply the largest generating unit at Eastlake.

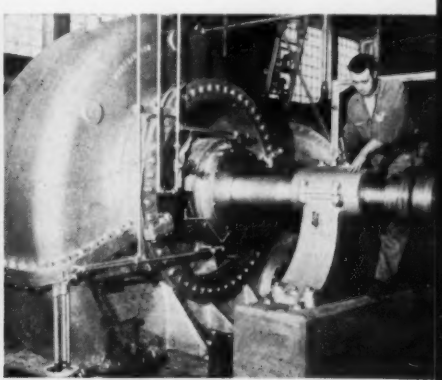
One of the world's most modern, the Eastlake Station of The Cleveland Electric Illuminating Company has a generating capacity of 660,000 kw.



Condensate Pumps. Behind these pumps is the 110,000 sq. ft. condenser serving largest Eastlake generating unit.



Compressors. One of three Worthington horizontal duplex units which supply all of the air for Eastlake's operation.



Circulating Pumps. This main condenser circulating pump, at Eastlake, is of Worthington volute "Mixflo" type.

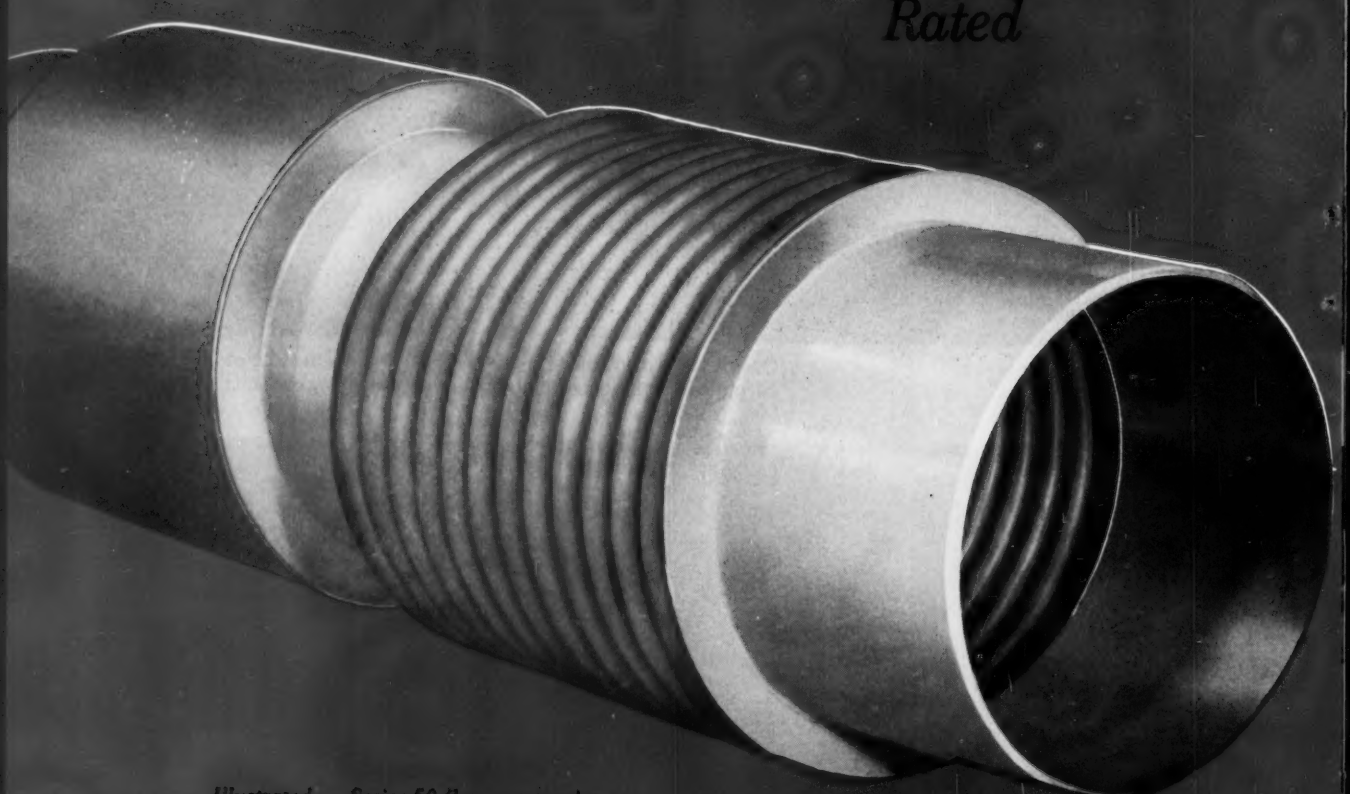
a **NEW DESIGN** from the world's

BADGER

S·R*

EXPANSION JOINTS

* *Service-Rated*



Illustrated — Series 50 (low pressure) S-R Double Joint with welding ends. Cover removed from one bellows.

most experienced manufacturer

Revolutionary new design provides longer cyclic life... less weight... better equalization

Over three years of intensive research and testing have paid off! Badger S-R Expansion Joints — corrugated packless expansion joints of an entirely new design — are ready for your most exacting power, heating, industrial and process piping applications.

Two significant features of the new joints are 1.) Curvilinear Corrugations, which result in natural "all-curve" flexing and equal distribution of movement among the corrugations; 2.) tubular Reinforcing Rings, which work with the new corrugations to produce greater effective flexing height and "all-curve" flexing even under higher pressures and temperatures.

And there are other important features, too . . . size for size, Badger S-R Joints weigh up to 50% less than conventional types . . . new ring design reduces joint diameter . . . a complete line of accessories — including covers and liners — are available . . . standard models in stainless, monel and inconel, special types in any workable alloy.

Cutaway view Series 150 (intermediate pressure) S-R Joint

New corrugation and ring designs produce better equalization, "all-curve" flexing

Series 50 (low pressure) S-R Expansion Joints

The radically different Curvilinear Corrugations used in Badger S-R Expansion Joints were developed by the Badger Research Department. As shown in the cross-section of a Series 50 Joint (left), the design produces more uniform movement per corrugation and flexing to a natural "all-curve" shape, which results in lower stresses and therefore increased life. (White line in diagram shows the efficient "all-curve" shape the corrugations *naturally* assume under operating pressures.)

Series 150 (intermediate pressure) S-R Expansion Joints

Series 150 S-R Joints feature Curvilinear Corrugations and, because they are used at higher pressures, also have tubular Reinforcing Rings. A significant engineering improvement, these new rings make metal-to-metal contact only in the "valley" of each corrugation yet allow natural "all-curve" flexing (white line) when the pipeline is subjected to pressure. The tubular shape of the rings also permits greater effective flexing height and therefore contributes to longer joint life.

Learn more about ways S-R Joints can be of advantage to you . . .

New illustrated brochure describes them in detail — mail coupon for your free copy today.

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Company _____

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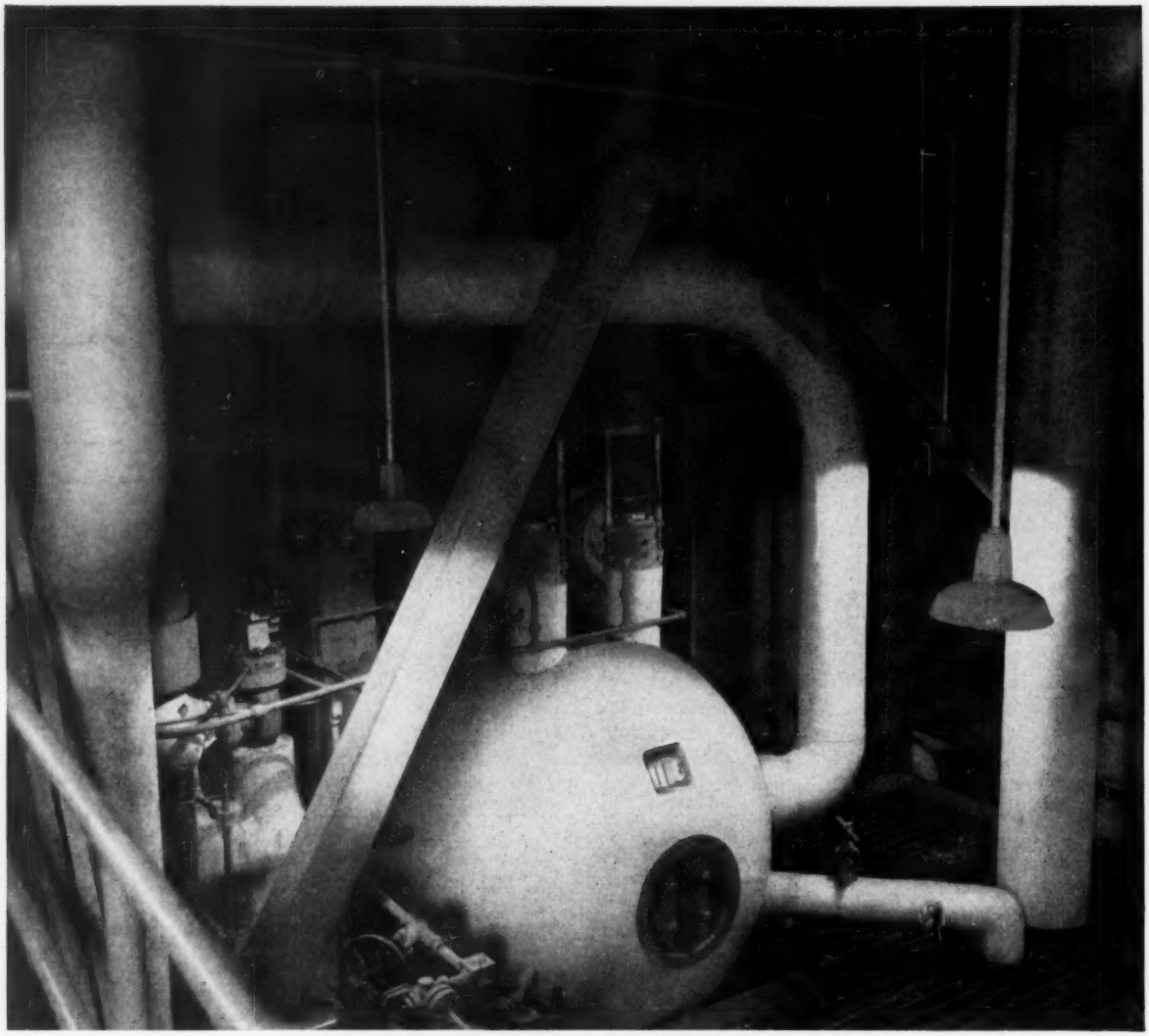


Modern plant, modern insulation! In this new, up-to-date plant the boiler drum and piping pictured are insulated with K&M Hy-Temp Combination insulation for temperatures up to 1900° F.

Keep heat where it pays—use

K&M HIGH-PRESSURE INSULATIONS

On the toughest heat-saving jobs, these K&M High-Pressure Insulations cut waste, save you money, and give more precise process control.

Temperatures to 1900° F. call for K&M Hy-Temp Combination Insulation... a layer of diatomaceous silica overlaid with K&M "Featherweight"® 85% Magnesia. Joints are staggered to prevent heat loss through expansion-caused openings.

Temperatures to 600° F. call for K&M "Featherweight" 85% Magnesia, made of basic carbonate of magnesia and asbestos fiber. And K&M "Featherweight" 85% Magnesia is good for the life of the equipment it serves.

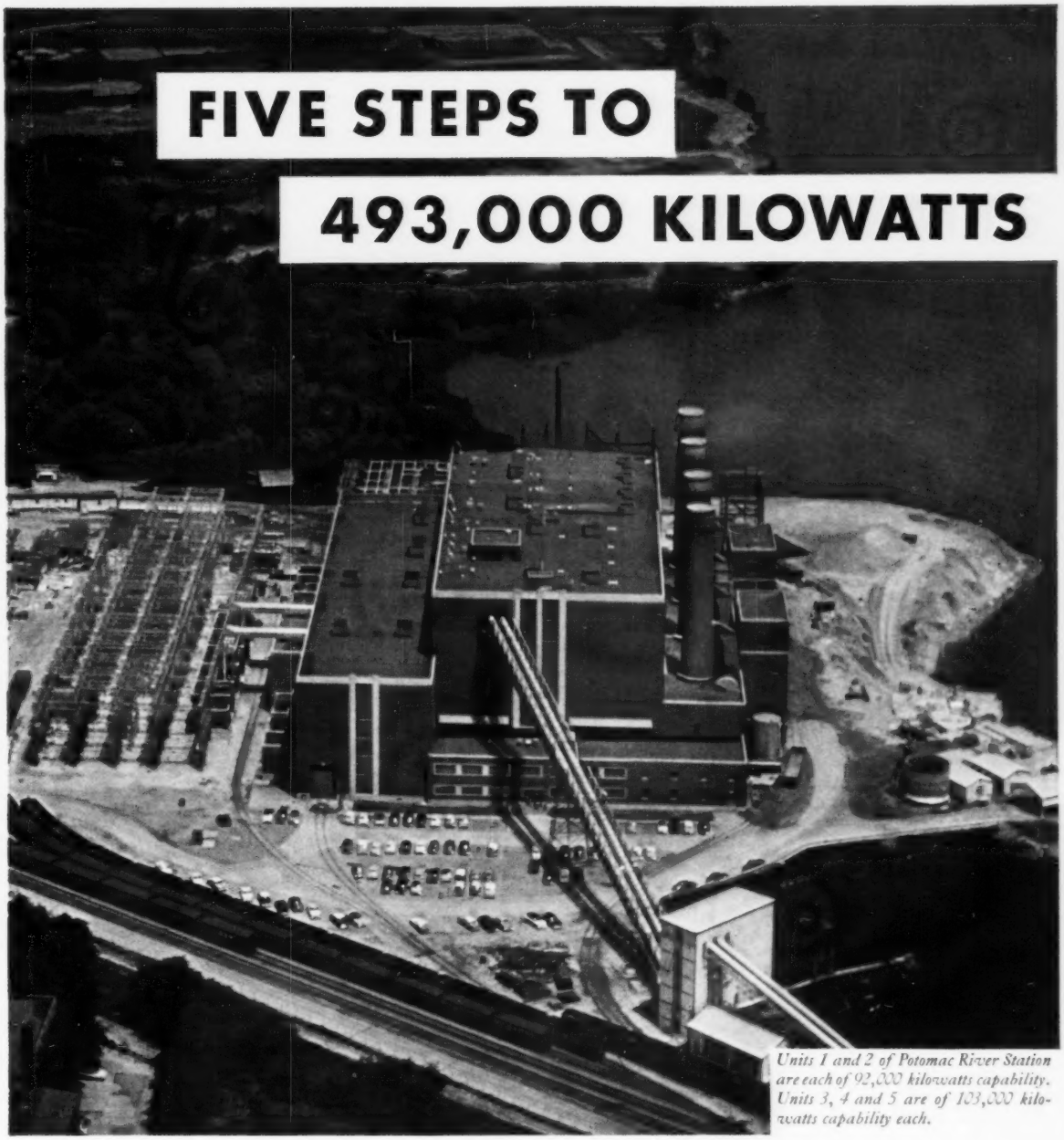
For information contact your K&M distributor, who is an experienced applicator. Or write directly to us.

KEASBEY & MATTISON COMPANY • AMBLER • PENNSYLVANIA

In Canada: Atlas Asbestos Company, Ltd.; Montreal, Toronto, Winnipeg, Edmonton, Vancouver

K&M best in asbestos®

FIVE STEPS TO 493,000 KILOWATTS



Units 1 and 2 of Potomac River Station are each of 92,000 kilowatts capability. Units 3, 4 and 5 are of 103,000 kilowatts capability each.

- The initial installation of Potomac Electric Power Company's Potomac River Steam Station serving the District of Columbia and surrounding territory was completed in 1949.
- A second unit was installed in 1950.
- The third unit was installed in 1954.
- Unit #4 went on the line in 1956.
- And a fifth unit is scheduled for completion in 1957.
- Total capability of the five units will be 493,000 kilowatts.

The design and construction of the entire station was by Stone & Webster Engineering Corporation.

If you have a problem of design or construction, our broad experience in these and related fields may help you solve it. Write or call us for complete information on our services.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY of STONE & WEBSTER, INC.

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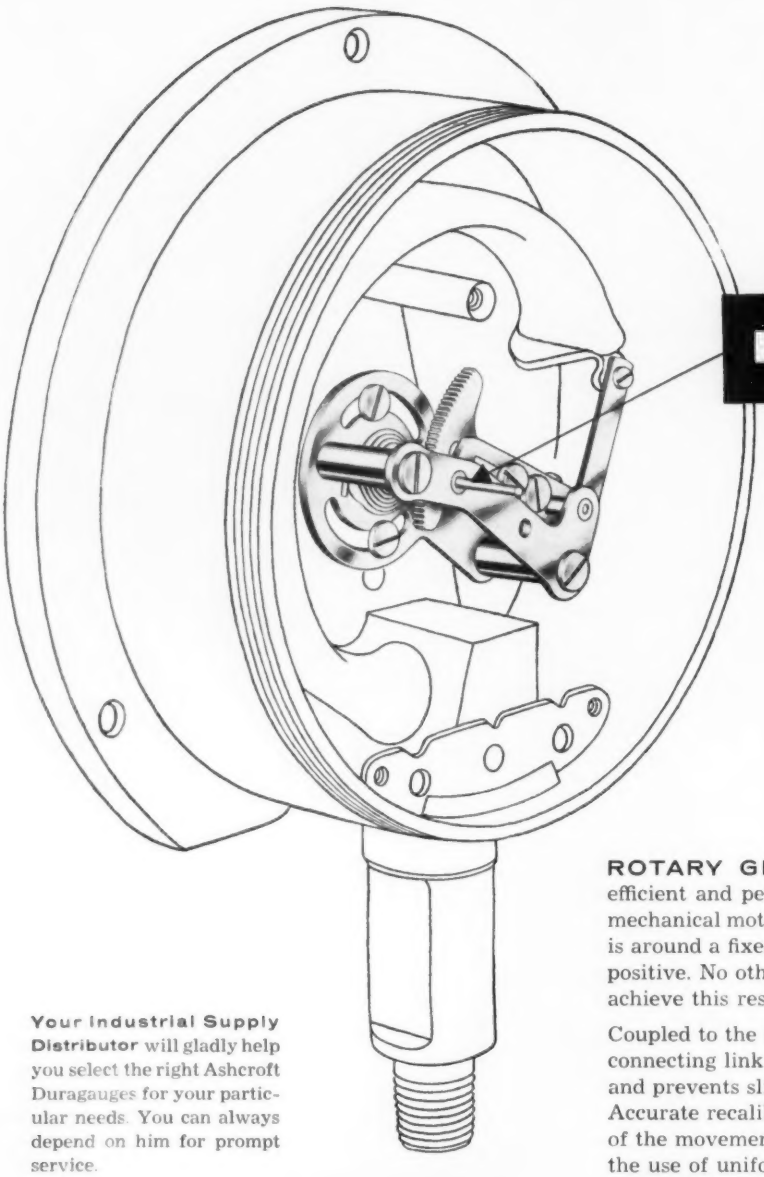


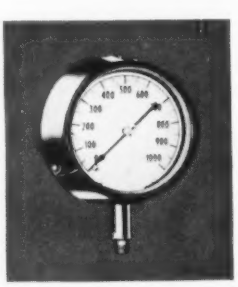
Why does the MOVEMENT in the ASHCROFT DURAGAUGE outperform all other types?

ROTARY GEARED MOTION, the most efficient and perfect method of transmitting mechanical motion ever developed. Because rotation is around a fixed center, pointer position is always positive. No other type of movement can ever achieve this result.

Coupled to the movement is a one-piece connecting link that guarantees correct calibration and prevents slippage or parting under tension. Accurate recalibration is easy from front or rear of the movement. Universal adjustability permits the use of uniformly graduated dials, thereby facilitating maintenance.

The Ashcroft Duragauge is available with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. There are case designs and materials, Bourdon tube materials, pressure ranges and dial sizes to meet your service conditions exactly. Save time, trouble and money. Specify the pressure gauges of highest sustained accuracy and durability – Ashcroft Duragauges.

Your Industrial Supply Distributor will gladly help you select the right Ashcroft Duragauges for your particular needs. You can always depend on him for prompt service.

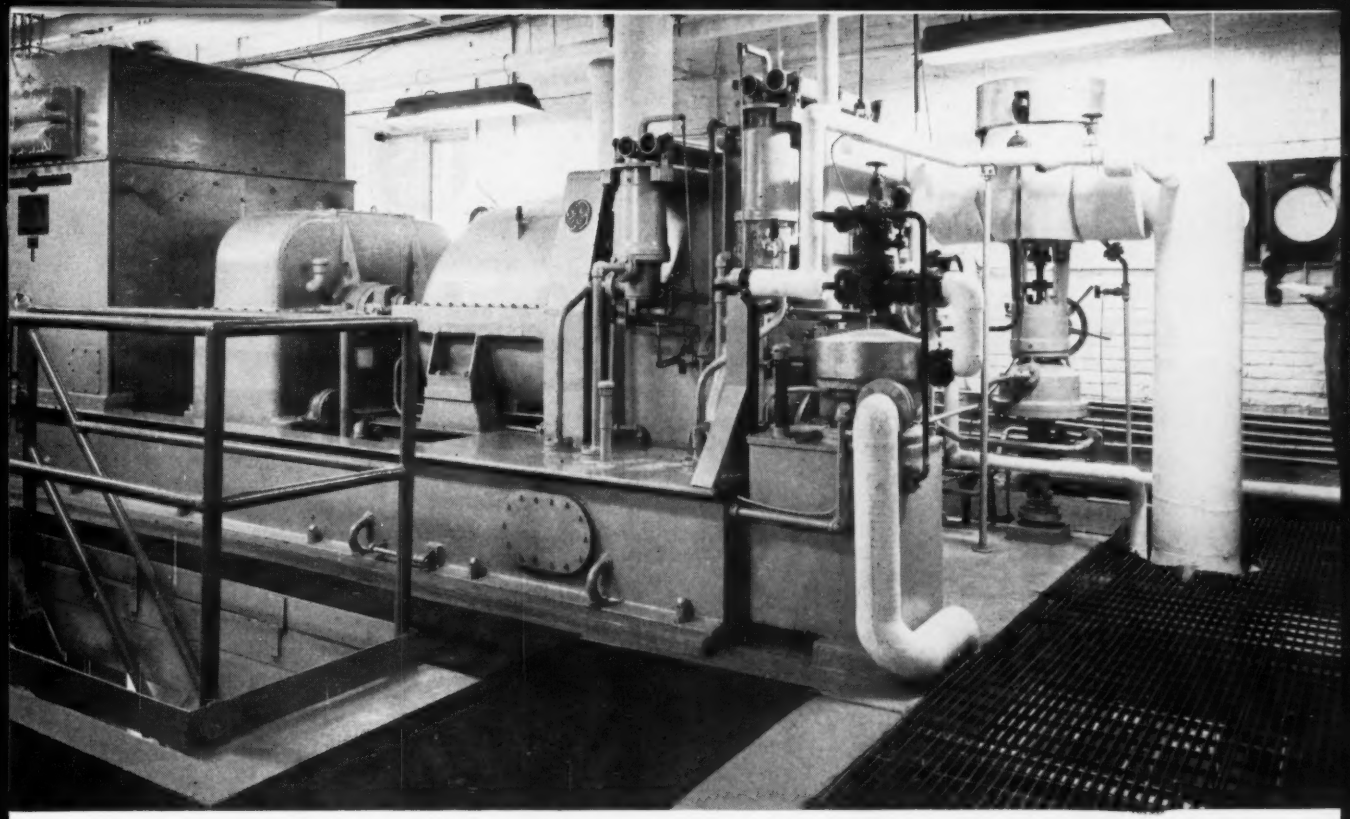


In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

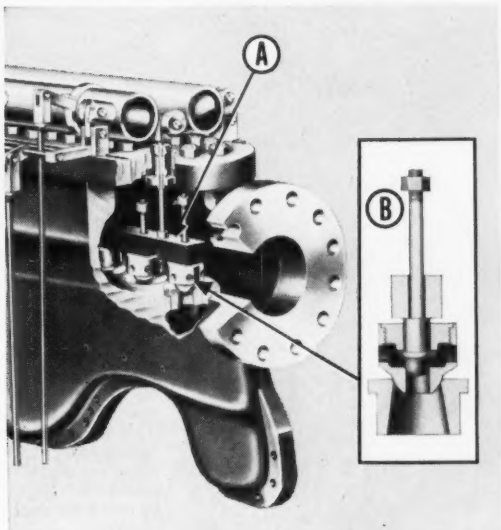
MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*



1500-kw General Electric steam turbine-generator installed at Foster Paper Company, Utica, New York.

General Electric's simplified valve gear offers more efficient turbine governing

DESIGN FEATURES PROVIDE CLOSE CONTROL, EASY MAINTENANCE



A. SIMPLIFIED BAR-LIFT arrangement of poppet-type valves has few parts, requires less maintenance.

B. DOUBLE-LIFT VALVES used on G-E high-speed turbines are a valve-within-a-valve arrangement. This means that the force required to open a valve is reduced allowing closer speed control over process operations.

*In Canada, contact Canadian General Electric, 107 Park St., Peterborough, Ont.

Here's another answer to requirements for safer, surer high-speed turbine operation. General Electric's simplified sectional valve gear mechanism offers more efficient governing and an improvement in heat-cycle efficiency.

SIMPLICITY OF DESIGN and easy maintenance are provided by a bar-lift arrangement of poppet-type valves, each of which supplies steam to part of the nozzle area. As less flow is required, these valves are successively closed to keep the nozzle area in proportion to the steam required. The result is more accurate control of steam flow and reduced throttling losses.

INCREASED GOVERNING EFFICIENCY is also provided by the best combination of valves and seats. Single- or double-poppet valves and angle or venturi seats are available to meet your specific requirements. Nozzle area can then be matched with the proper valve combination to obtain uniform horsepower gradient.

These simplified valve gear components are still another example of the sound engineering built into every General Electric high-speed turbine. For complete information, contact your nearest General Electric Apparatus Sales Office*, or write for bulletin GEA-6232, General Electric Company, Section 241-9, Schenectady, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

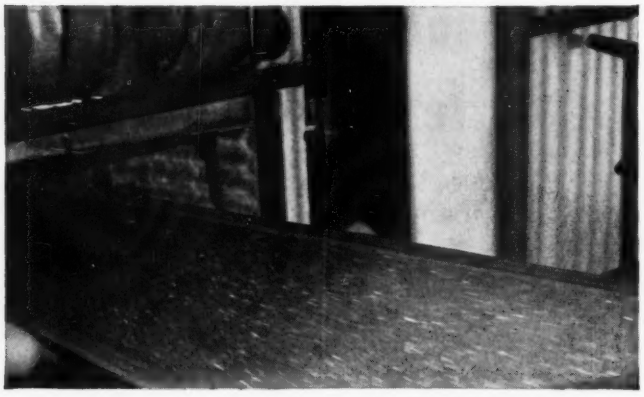
US RUBBER CONVEYOR BELTING

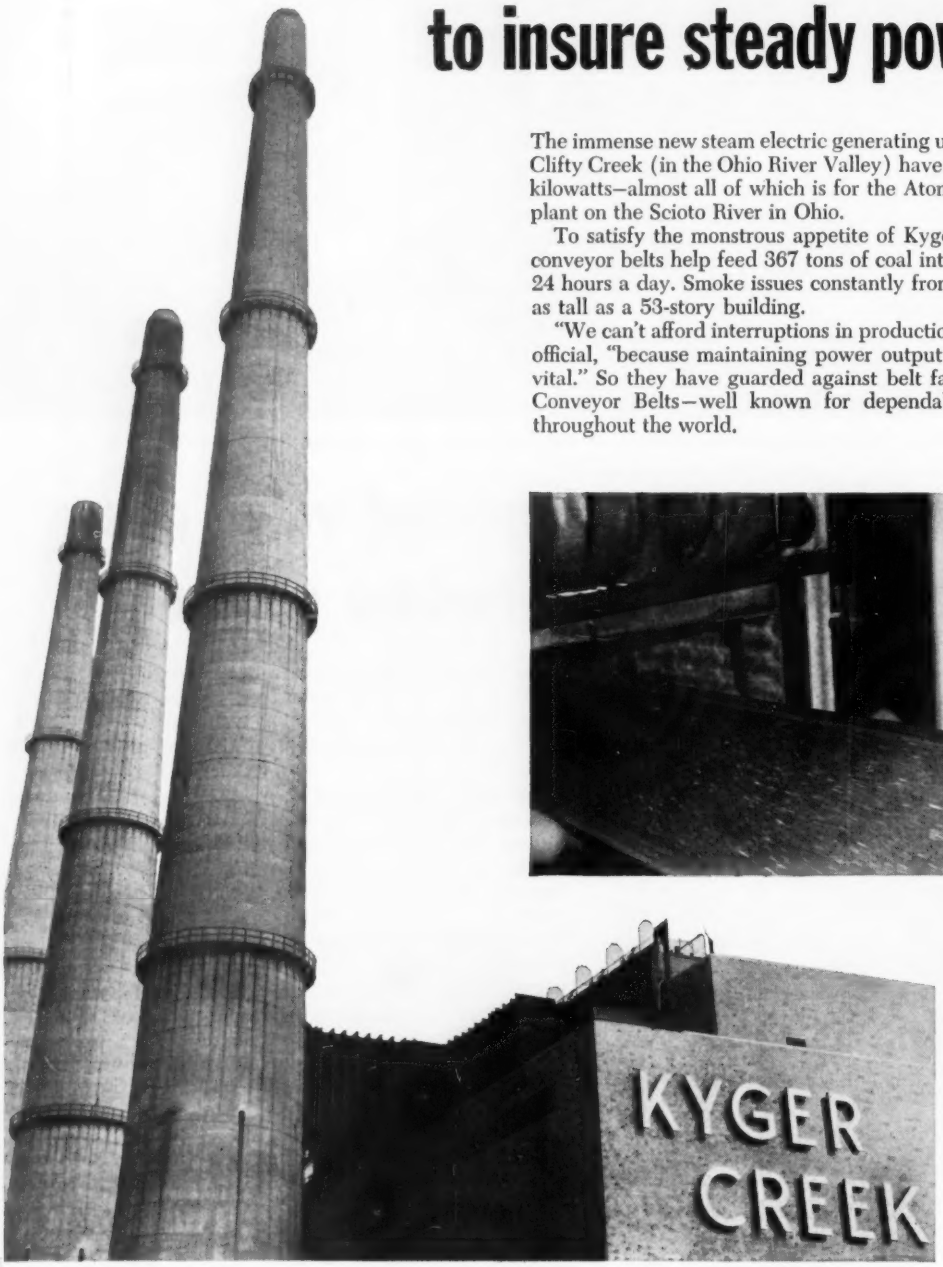
Delivering 367 Tons of Coal per Hour... to insure steady power flow

The immense new steam electric generating units at Kyger Creek and Clifty Creek (in the Ohio River Valley) have a capacity of 2,365,000 kilowatts—almost all of which is for the Atomic Energy Commission plant on the Scioto River in Ohio.

To satisfy the monstrous appetite of Kyger Creek, U. S. Rubber conveyor belts help feed 367 tons of coal into its boilers every hour, 24 hours a day. Smoke issues constantly from the giant stacks, each as tall as a 53-story building.

"We can't afford interruptions in production," says a ranking plant official, "because maintaining power output for the atomic plant is vital." So they have guarded against belt failure by selecting U. S. Conveyor Belts—well known for dependability by power plants throughout the world.





(above)
The Number One conveyor belt emerging from the unloader hopper at Kyger Creek. This 48" wide U. S. Matchless® belt provides excellent troughability, extreme rip resistance, fine training and long life. This excellent conveyor system and belting mean considerable savings in manpower to move the coal supply.

EXPANSION JOINTS

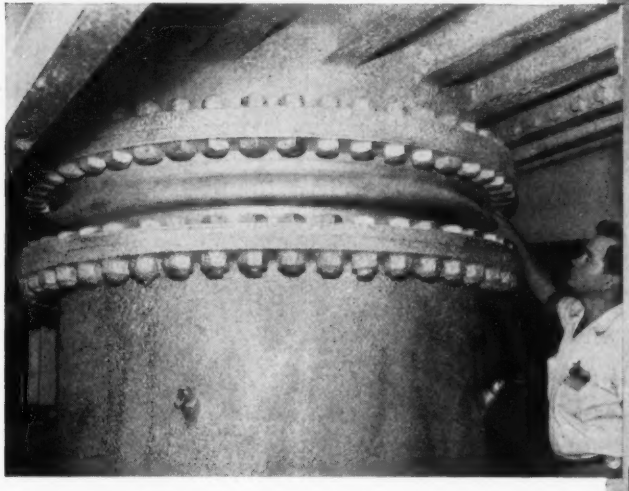
84,000 Gallons of Water per Minute for atomic energy plants

The Clifty Creek steam electric plant brings in and expels river water at 84,000 gallons per minute, by means of circulating water pumps. To help quench this huge thirst, U. S. Rubber Expansion Joints (from small 8-inch type to big 66-inch type) are used on the water intake and discharge pipes.

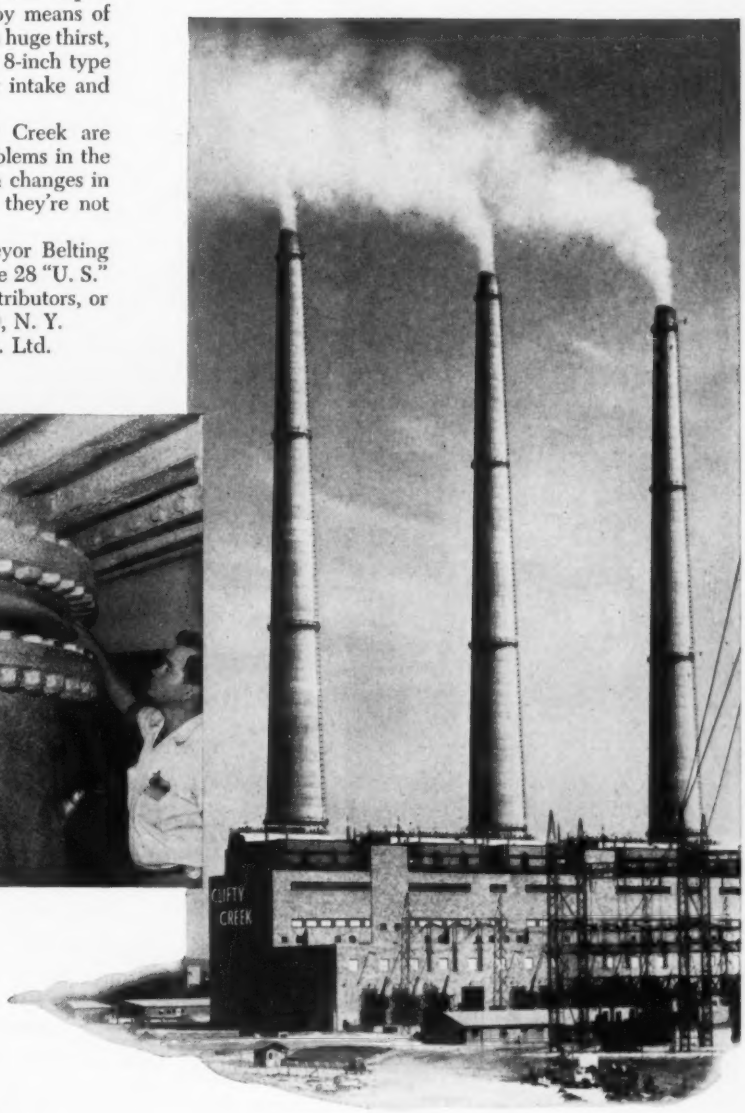
These U. S. Expansion Joints at Clifty Creek are handling the contraction and expansion problems in the pipe lines excellently. They can take sudden changes in temperature, they can handle shocks, and they're not bothered by corrosion.

A complete line of U. S. Rubber Conveyor Belting and Expansion Joints is available at any of the 28 "U. S." District Sales Offices, at selected "U. S." distributors, or write us at Rockefeller Center, New York 20, N. Y.

In Canada, contact Dominion Rubber Co. Ltd.



Above is one of the many 66-inch U. S. Expansion Joints on a water intake line at the Clifty Creek Plant. None of these joints, no matter what the size, has ever given Clifty Creek any problem. They are performing excellently, on a tough job.

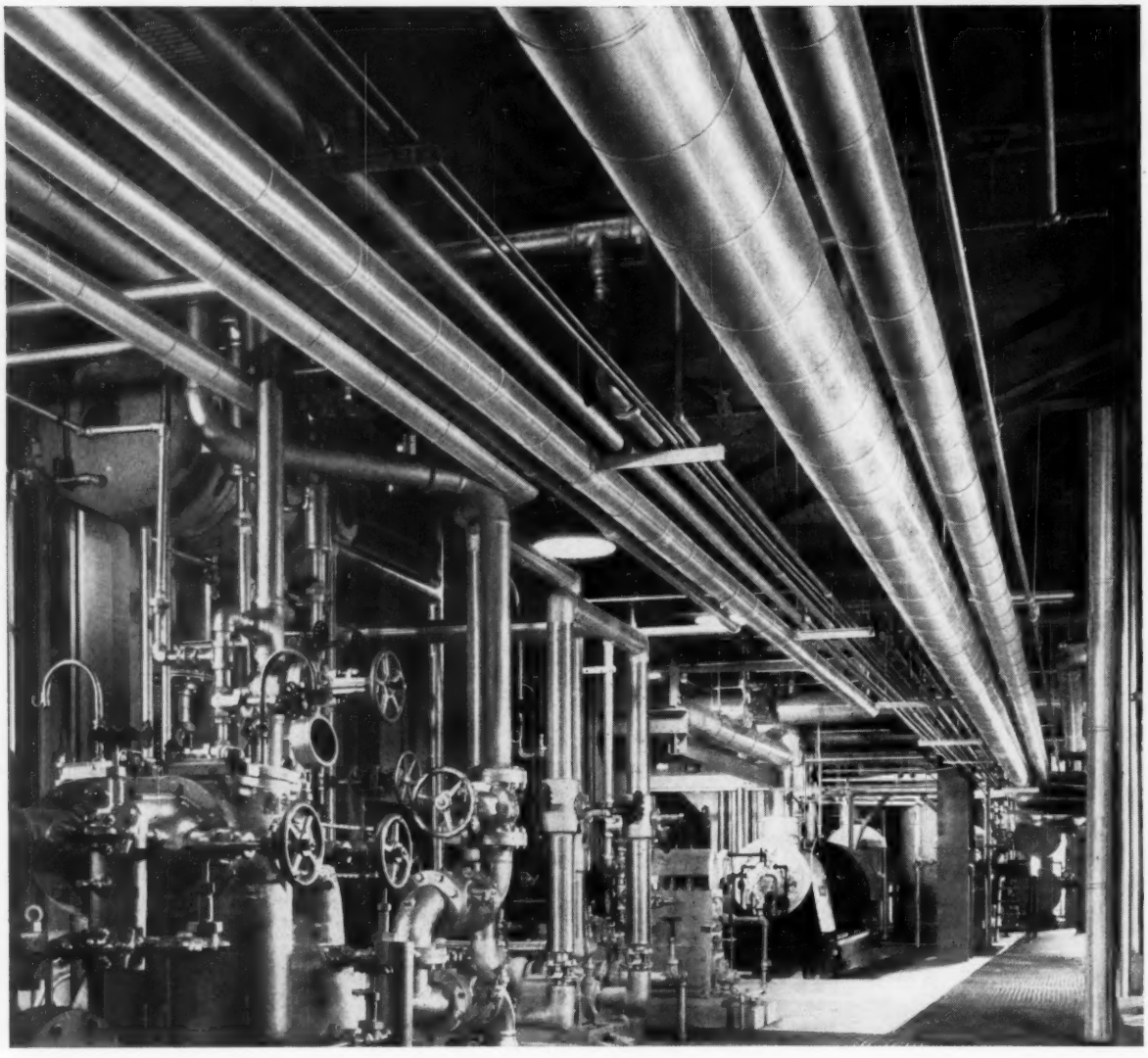


Mechanical Goods Division

United States Rubber

Kaiser Aluminum snap jackets give you

A NEW, FASTER WAY TO



Now, with *snap jackets* made with Kaiser Aluminum, one man can install aluminum pipe jacketing quickly and economically.

An outstanding example of recent improvements in aluminum jacketing techniques, the *snap jacket* is a sheet of Kaiser Aluminum, roll-formed into a tubular shape and stiffened along one edge by an angular crimp. Rigid, but sufficiently flexible, the jacket can be quickly snapped into place around insulated pipe by only *one man* and assures a more durable, more weather-tight installation.

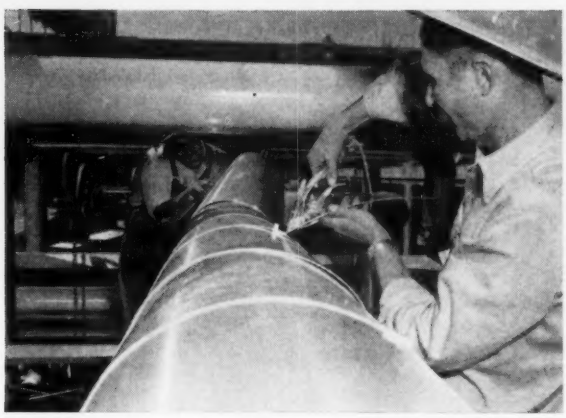
Because it is made with Kaiser Aluminum, the *snap jacket* gives you improved appearance and longer life at low cost.

For immediate assistance on any jacketing requirements, call the Kaiser Aluminum sales office listed in your phone directory. Process Industries Department, Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office,* Palmolive Bldg., Chicago 11, Illinois; *Executive Office,* Kaiser Bldg., Oakland 12, California.

INSTALL ALUMINUM JACKETING

1. ONE MAN can quickly position tubular *snap jacket* for installation.

2. NEXT, same man easily snaps *snap jacket* around pipe, places laps properly and bands the jacket to complete the job.



3. TO SAVE even more time, two men can work together . . . one man snaps jackets in place, follow-up man bands them.

For this new, faster way to install aluminum jacketing, Kaiser Aluminum alloy 5005-H16 is recommended. Other alloys may be used depending on the job, but it is desirable to use one alloy throughout.

Recommended thicknesses of sheet aluminum:

For insulation O.D. of 12.75" and under	**0.020"**
For insulation O.D. of 14" and larger	**0.024"**

Kaiser Aluminum

materials for the process industries

For *complete* information about aluminum jacketing with illustrated on-the-job techniques, send for the new 40-page *free* manual "Kaiser Aluminum Insulation Jacketing Materials And Methods."

MAIL THIS COUPON TODAY!

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Please send my copy of your new manual "Kaiser Aluminum Insulation Jacketing Materials And Methods." I understand there is no obligation.

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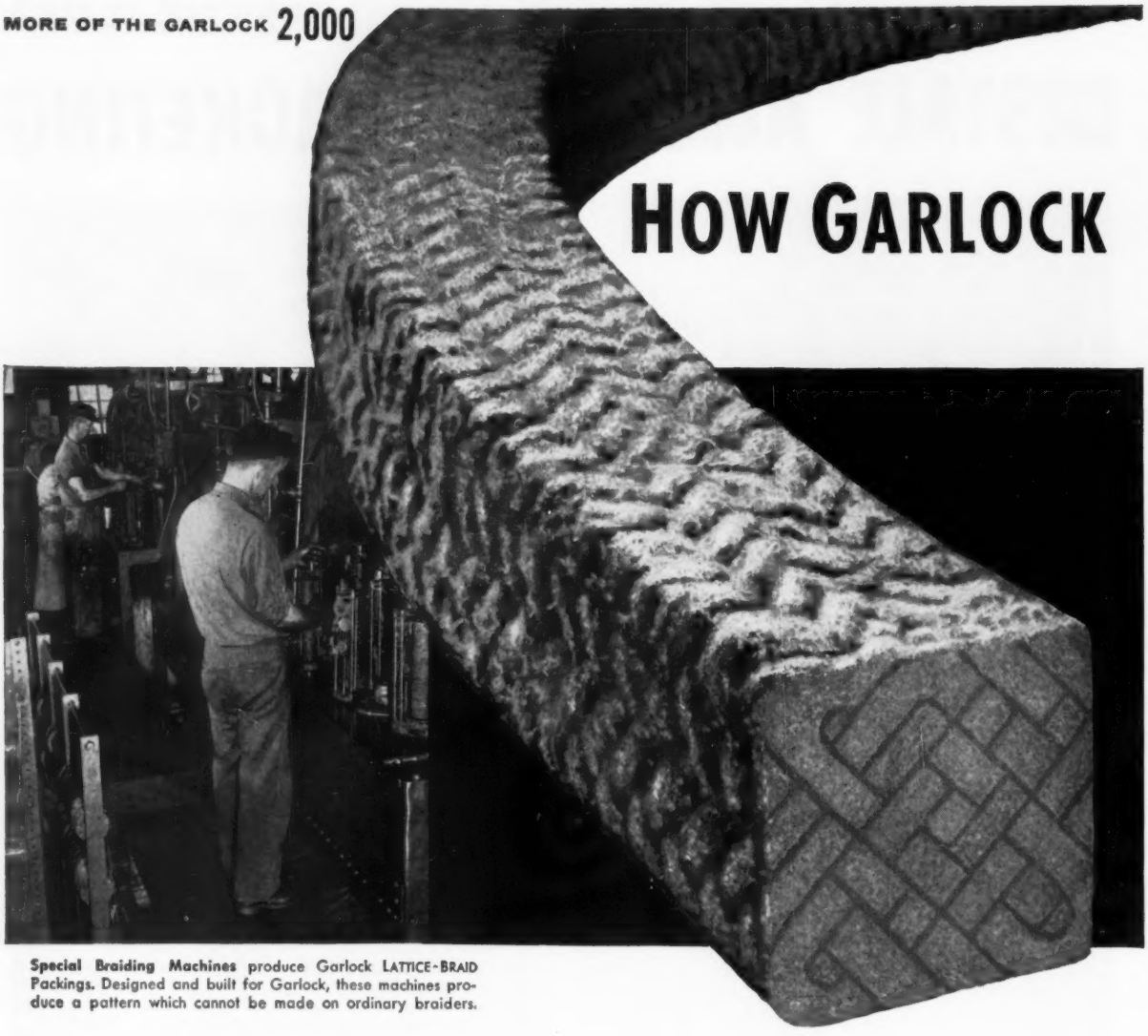
MORE OF THE GARLOCK 2,000

HOW GARLOCK



Special Braiding Machines produce Garlock LATTICE-BRAID Packings. Designed and built for Garlock, these machines produce a pattern which cannot be made on ordinary braiders.

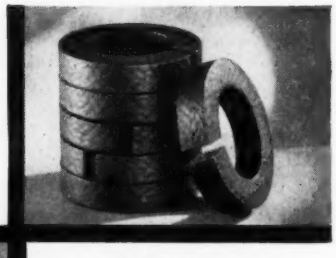
Users Report:

Chemical Industry

Centrifugal dye pumps required repacking every 24 to 48 hours. Changed to LATTICE BRAID asbestos packing with Teflon impregnation. Results: minimum of 3 month's service.

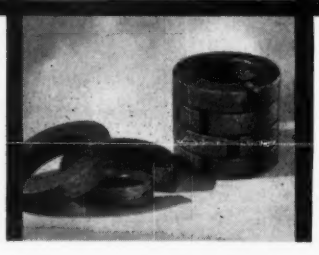
Food Industry

LATTICE-BRAID blue asbestos packing, Garlock 5880 in constant use 24 hours a day on centrifugal prune pulp pump and still in service after 8 months.



Metalworking Industry

LATTICE-BRAID flax outlasts ordinary braided flax three to four times on accumulators, hydraulic rams, lifts, etc. . . . does not break up and rams show less wear.



Oil Industry

Centrifugal transfer pump alternately handling caustics, lime, acid and solvents at temperatures to 200° F. was repacked twice a week . . . shaft replaced twice a year. LATTICE-BRAID has given 10 months continuous service . . . saving over $100. already in materials alone.

LATTICE-BRAID* PACKINGS DIFFER

from Ordinary Braided Packing

The Garlock LATTICE-BRAID Packing is distinctly different . . . the result of many years of development and experimental work.

Special machines are required to manufacture the LATTICE-BRAID structure. And the superiority of LATTICE-BRAID packings is due to the unique braiding pattern which cannot be duplicated on ordinary braiding machines.

ADVANTAGES: unified structure gives greater strength; no disintegration; less gland adjustment; unusual flexibility.

**Registered Trade Mark*

Garlock LATTICE-BRAID. Every strand passes diagonally through body of packing at approximately 45° angle producing completely unified structure. Every strand contributes to strength of entire mass.

Ordinary square braid. Each strand merely passes over and under other strands. No strand passes entirely through packing. No common linkage . . . no unified structure, less strength.

Ordinary round braid packing is built-up to size by braiding one or more covers over a solid core. No unified structure—when outside covers wear through, packing is no longer serviceable.

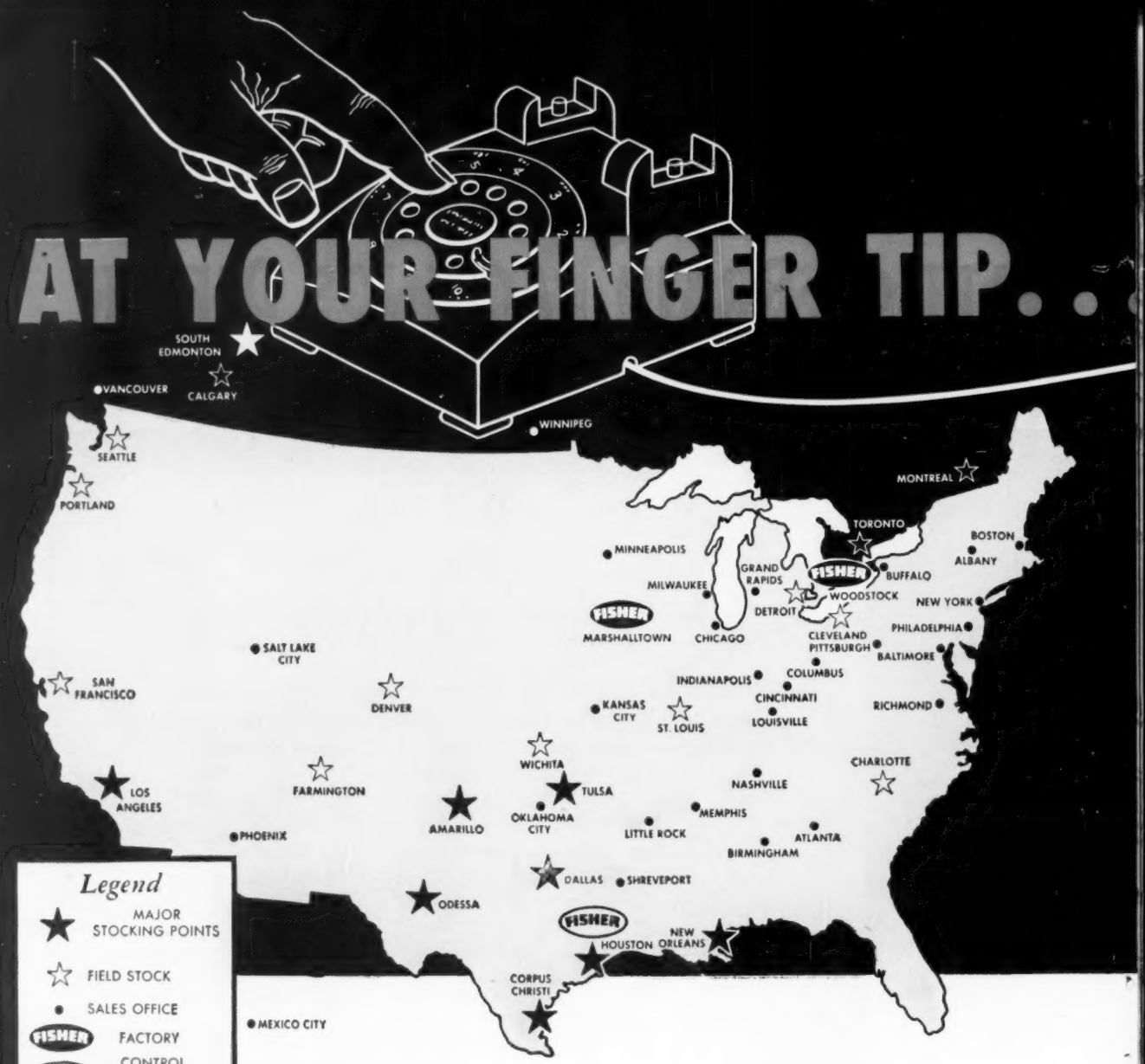
LATTICE-BRAID is another important part of "the Garlock 2,000"...two thousand different styles of packings, gaskets, and seals to meet all your needs—the *only* complete line. That's why you get *unbiased* recommendations from your Garlock representative. Call him today or write for LATTICE-BRAID Folder AD-131.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints



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Whether your problem is one of existing equipment—or an entirely new control application—the Fisher country-wide network of 3 factories, 22 strategically located field stocks and 53 representatives, with 203 Fisher Service Engineers—offers you convenient service on all your control requirements.

FISHER GOVERNOR COMPANY

Marshalltown, Iowa — *Woodstock, Ontario*

World Leader In Research for Better Pressure and Liquid Level Control

FISHER SERVICE DIRECTORY

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AMARILLO
Vinson Supply Co.
ATLANTA
Jack M. Smither & Co.
BALTIMORE
Rhodes Controls Co.
BIRMINGHAM
Jos. W. Eshelman & Co.
BOSTON (NEEDHAM)
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W. J. Sommers Co., Inc.
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Barber Engineering & Supply Co.
CHARLOTTE
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DALLAS
Vinson Supply Co.
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FARMINGTON
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INDIANAPOLIS
Acme Engineering Agency
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Carter-Jones Co.
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Babcock & Wilcox de Mexico, S. A.
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NEW YORK (ENGLEWOOD CLIFFS, N. J.)
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ODESSA
Vinson Supply Co.
OKLAHOMA CITY
Vinson Supply Co.
PHILADELPHIA (NARBERTH)
C. B. Ives & Co., Inc.
PHOENIX
Cone & Wallace Co.
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J. G. Chilcoat & Co.
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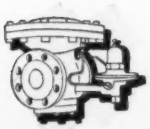
G. W. Beecroft Co., Ltd.
TULSA
Vinson Supply Co.
VANCOUVER
Northern Columbia Process Equip., Ltd.
WICHITA
Sullivan-Mears Company
WINNIPEG
Mechanical Valve & Engineering Specialties
WOODSTOCK
Fisher Governor Co.

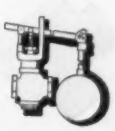

PRESSURE REGULATORS

GAS REGULATORS

LIQUID LEVEL CONTROLLERS

DIAPHRAGM CONTROL VALVES

PUMP GOVERNORS


LEVER AND FLOAT VALVES

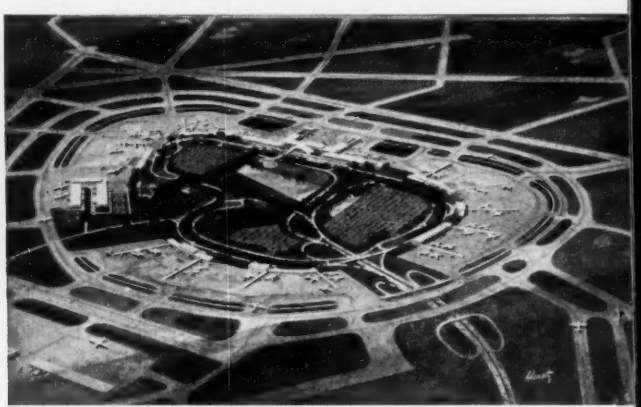
$90,000,000 Idlewild expansion program uses

New TERMINAL CITY covers 655 acres. The steel framework for the central heating plant can be seen in the center of this panoramic view. Steam and refrigerated lines run from it to all of the proposed buildings.

1.

2.

3.



Artist's sketch of Terminal City showing proposed buildings and extent of high temperature hot water system.

1. LARGE TRENCH shows one expansion loop in foreground and another in background. Note large pipes for chilled water lines running outside of the walled trench containing the high temperature hot water system. The control tower is in the center of the photograph, and the new International Arrival Building is at the right of the tower. The bags of GILSULATE are slid down boards into the trench.

2. 1100-FOOT TRENCH clearly shows the concrete pad on which the hot water pipes are laid (across cement-filled transite supports). The large pipes containing chilled water are insulated with other materials. At a later stage, the hot water system will be walled in by concrete slabs. The ditch is cleaned and drained before GILSULATE is poured.

3. INSPECTOR CHECKS thickness of GILSULATE covering over an expansion loop.

1515 tons of Gilsulate to protect 7 miles of pipe

Consulting Engineers: Seelye, Stevenson, Value & Knecht; Heating Contractors: Almirall & Co., Inc. and Norman Heating Co., Inc.; Eugene J. Brandt & Co., Inc.

New York International Airport has one of world's largest high temperature hot water systems

By 1960 "Terminal City" will be completed at New York International Airport. This gigantic undertaking comprises 655 acres, 7½ miles of taxiways, 10 miles of 2-lane roads, a huge International Arrival Building and two adjacent Airline Wing Buildings (eleven city blocks long), plus individual terminal buildings. The $90,000,000 facility will handle 140 aircraft at one time.

Running from a central heating plant to each of the projected buildings in Terminal City is one of the world's largest high temperature hot water systems ever designed. This system, operating at 380°F on the supply and 240°F on the return lines, includes 38,774 feet of pipe (7.34 miles!), virtually all of which is protected with 1515 tons of Type B GILSULATE. In this gigantic system, expansion loops alone total one mile!

The vastness of this installation and the sandy terrain at Idlewild created unusual design problems. Before the pipes were laid, concrete slabs were put down. Concrete slabs or block retaining walls were erected to form a trench for the high temperature hot water system.

Big job or small, GILSULATE offers equal unique protection for underground hot pipes—and the same opportunity for on-the-job savings. GILSULATE is easy to install; calls for no specially trained installers, no special installing equipment. Whether *your* piping job is large or small, you'll find that GILSULATE fits your specification picture—at a lower cost per installed linear foot than any other underground hot pipe insulation.

See your local GILSULATE distributor—or fill in the coupon below for more complete information.

FACTS ABOUT GILSULATE

1. **Easy to use**—just pour and tamp... pipe heat does the rest.
2. **Forms 3 zones** of protection against heat loss and all hazards commonly encountered by hot buried pipes.
3. **Needs no housing or mechanical sheaths:** no mixing, special handling or equipment.
4. **Only needs normal pipe spacing:** for multiple pipe or cramped conditions.
5. **Three types available:**
   Type A for 220°-300°F. temp. range
   Type B for 300°-385°F. temp. range
   Type C for 385°-520°F. temp. range

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Affiliate of Barber Oil Corp. & Standard Oil Co. of California
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THE TRIPLE ZONE INSULATION SYSTEM FOR LIFETIME PROTECTION OF UNDERGROUND HOT PIPES

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Send me more information on GILSULATE Insulation

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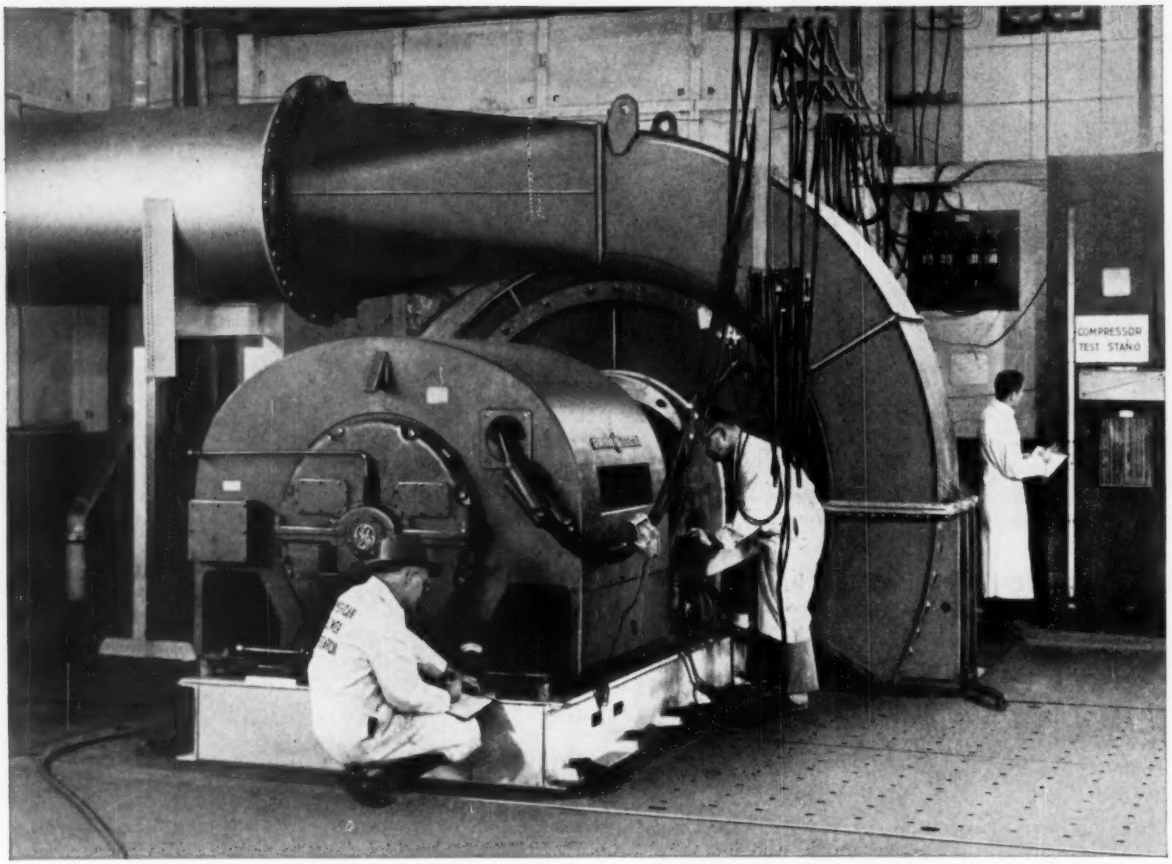
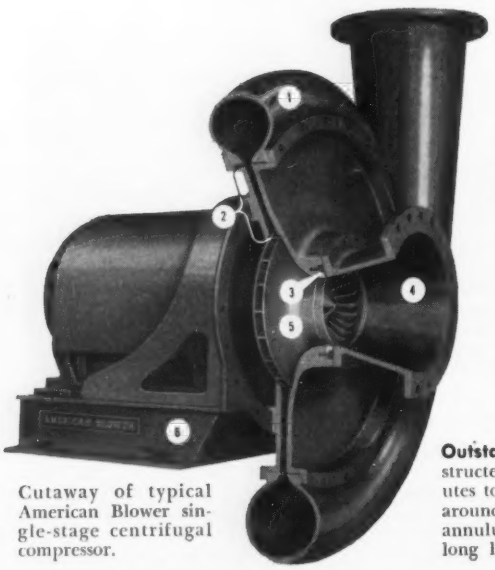
P

Here's the latest air-handling



LABORATORY TESTED CENTRIFUGAL COMPRESSOR DELIVERS 330,805 POUNDS OF AIR PER HOUR!



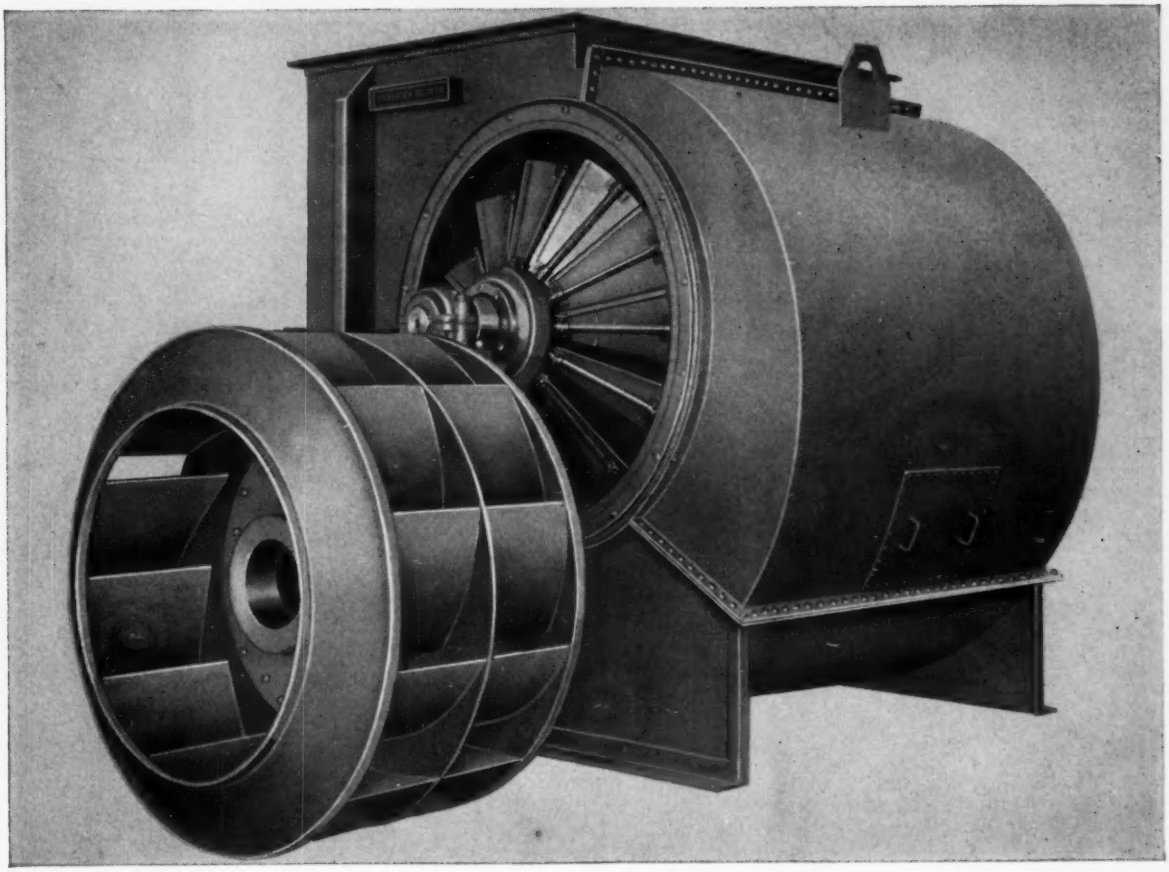
Cutaway of typical American Blower single-stage centrifugal compressor.

With the trend toward higher pressure requirements, American Blower has designed and built centrifugal compressors to furnish air for cyclone fired boilers. These compressors incorporate the use of a horizontally split, welded steel volute casing, variable inlet guide vanes, welded steel impeller of the shrouded type with impeller shaft supported by two journal bearings plus a Kingsbury thrust bearing arranged for positive forced-feed lubrication. This highly efficient compressor is driven by a 1000 HP, 1800 rpm, induction motor, delivers 330,805 pounds of air per hour at a static discharge pressure of 67.5 inches water gauge.

Like every American Blower single-stage centrifugal compressor—30 to 2250 HP—this compressor has been completely tested in accordance with the A.S.M.E. Power Test Code. Such testing guarantees the mechanical operation and performance of all American Blower compressors.

Outstanding features: (1) Improved scroll-shaped casing design. (2) Unobstructed long diffuser passage converts velocity energy into pressure, contributes to quiet operation. (3) Annulus packing minimizes recirculation of gas around impeller inlet. (4) Removable inlet nozzle for accurate alignment of annulus packing. (5) Aero-dynamic design of impeller blades for high efficiency, long life. (6) Welded-steel baseplate "stress relieved" prior to machining.

equipment from American Blower

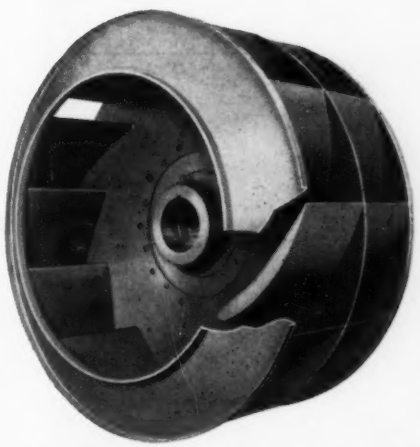


AIRFOIL FAN HAS ADVANCED DESIGN FOR HIGH EFFICIENCY, LOW OPERATING COST

Featuring a functionally designed airfoil blade, American Blower's improved Airfoil Fan is the industry's best in the non-overloading-horsepower type of centrifugal fan.

That's because smooth interworking of improved streamline inlets, wheel rims, and housing minimizes turbulence, resulting in higher efficiency, lower power consumption. The non-overloading-horsepower characteristic makes it possible to select a driving motor close to the fan horsepower.

Why not talk to an American Blower sales engineer about *your* requirements. His knowledge of air-handling applications can prove invaluable to you. Call our nearest branch office, or write: American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products.



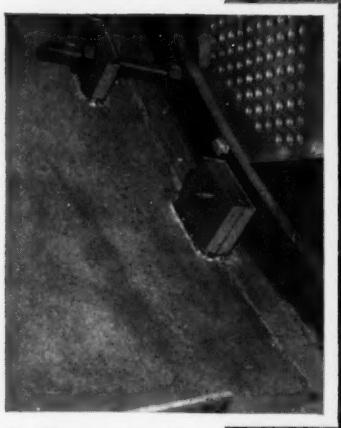
Special design of the airfoil blade and matching streamline inlet are the top features of American Blower Airfoil Fan. The dieformed, reinforced, and welded blades are extra strong, extremely efficient. Single- and double-inlet Airfoil Fans are available in many sizes, and for volumes up to 1,000,000 cfm.

AMERICAN BLOWER

Division of AMERICAN-Standard

BIG...
but built for easy installation

Unique field assembly and welding methods developed by Allis-Chalmers cut installation costs for Detroit Edison



Pull-up blocks and dowel blocks, shown above, are used to simplify alignment during installation.

Size alone dictated that this huge 115,000-square-foot condenser for The Detroit Edison Company's River Rouge Station be fabricated and shipped in sections. Here's the way this job was handled:

Before shipment, matching joints were machine scarfed for full penetration welds, and sections were carefully fitted together. Each joint was then equipped with "dowel blocks" and "pull-up blocks" as shown in the inset.

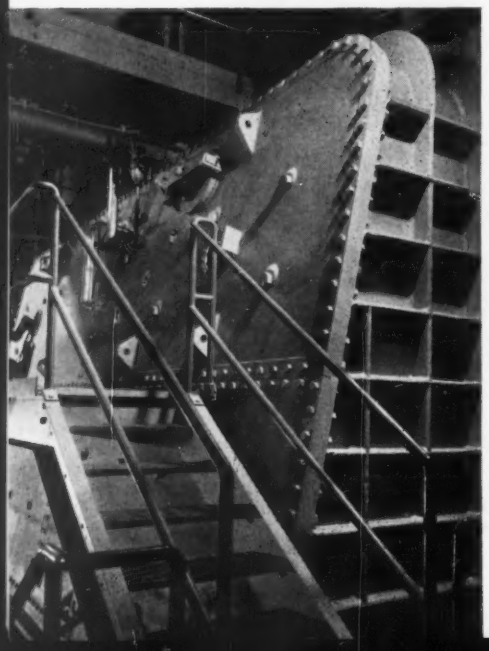
The condenser was then disassembled and shipped.

Joint Seal-Welds Eliminated

In final assembly, dowel blocks were lined up . . . pull-up blocks quickly brought sections back to original shop position, snugly, and units were welded. This minimized erection costs. Welding sections together, eliminating the necessity of seal-welds with bolted flange sections, provided a vacuum tight, maintenance-free joint.

This is typical of the design and engineering extras that you get when you specify Allis-Chalmers condensers.

Get information. Call your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.



Giant 115,000-square-foot condenser of new River Rouge Station.

ALLIS-

CHALMERS

A-5224

Putting fresh logs on the nuclear fire

Like the logs in a fireplace, the fuel of a nuclear reactor "burns out" after a time. By-products, created by irradiation, "clog" the atomic structure of the fuel element, and the release of heat energy diminishes.

When reactor fuel reaches this stage, it must be reprocessed in order to reclaim the valuable fissionable materials remaining. In this way nuclear power production can be maintained economically.

The reprocessing of spent fuel elements is a task that requires expert knowledge, specialized equipment, and considerable practical experience. It is, in general, an outside service that will be required by reactor operators.

With more than eight years of successful experience in solving advanced technical problems in atomic energy, Sylvania has long been a leading processor of reactor fuel elements and assemblies, as well as a pioneer in the development of fuel elements and reprocessing techniques. Whether your reactor plans are immediate or for the future...for power or research...international or domestic ...our scientific and engineering staff will gladly discuss your problems with you. For your files, write for Sylvania's just-published booklet on Nuclear Fuels.

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SYLVANIA ELECTRIC PRODUCTS INC.
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NEW!

TUBE-TURN* "TAPER FACE" FLANGE

...cuts cost of light-duty piping

...protects low pressure pumps and valves

Tube Turns announces a new lightweight welding neck flange for service up to 125 lbs. W.O.G. pressure, offering two important cost-cutting advantages: (1) It is priced lower than conventional flanges. (2) This lightweight welding neck flange has a tapered face which affords an effective seal with reduced bolt loading; hence, permits use of steel butt welding neck flanges without danger of cracking the flat faced cast iron flanges of valves and pumps used in low pressure piping systems. Here is another result of Tube Turns pioneering research, and an example of how you get *more for your money* when you specify TUBE-TURN Welding Fittings and Flanges and buy them from your nearby Tube Turns' Distributor.

tt
TUBE-TURN

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

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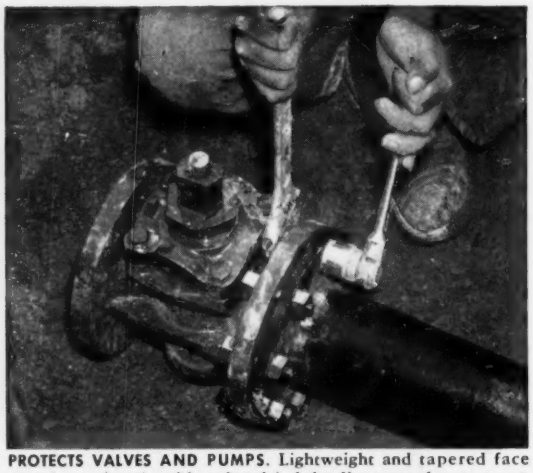
HOW TO SAVE

How you cut costs with
TUBE-TURN FLANGES

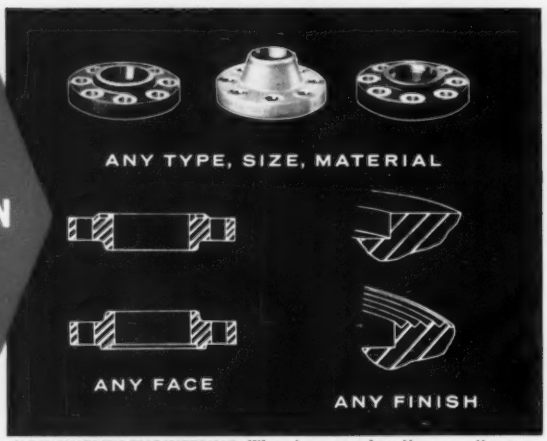
with the **NEW** Taper Face Flanges

CUTS FLANGE COSTS. For many applications of light-duty piping . . . up to 125 lb. W.O.G. pressure . . . the new TUBE-TURN Taper Face Flange gives rated performance at a lower price than conventional designs. Here's a good teammate for lightweight pipe and fittings in applications such as water, oil and gas distribution . . . on pumps and compressors . . . any installation where welded piping must be flanged to low pressure valves, pumps or equipment.



PROTECTS VALVES AND PUMPS. Lightweight and tapered face permit good seals with reduced bolt-loading on valve or pump flanges. Lighter, lower-priced valves can be used without danger of cracking their flat faced cast iron flanges. Also, lighter neck of flange speeds up welding to pipe.

with all **TUBE-TURN** Flanges



YOU SIMPLIFY ENGINEERING. There's a complete line . . . all types, sizes, capacities, materials. You can specify TUBE-TURN Flanges and know you'll get the exact answer to your problem. Also, Tube Turns offers you engineering help.

YOU STREAMLINE PURCHASING. Your nearby Tube Turns' Distributor provides complete-line service. This one source for all your needs in welding fittings and flanges enables you to put *all* your requirements on *one* order . . . to cut red tape, save valuable time.

MAIL FOR BOOKLET

The New line of Taper Face Flanges is described in this Tube Turns booklet . . . free on request.

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224 East Broadway, Louisville 1, Kentucky
Please send free Bulletin on Taper Face Flanges.

Company Name _____

Company Address _____

Your Name _____

Position _____

City _____ *Zone* _____ *State* _____

Available from your nearby TUBE TURNS' distributor

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

TUBE TURNS

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LOW VOLTAGE BREAKERS

Safe, Easy to Inspect . . . Simple, Easy to Mount

1. Easily accessible — Removal of deep front cover permits inspection and maintenance of breaker from front or sides.

2. Easy breaker removal — Pull-out construction permits removal without disconnecting cables. Cable connections are accessible through entire front opening.

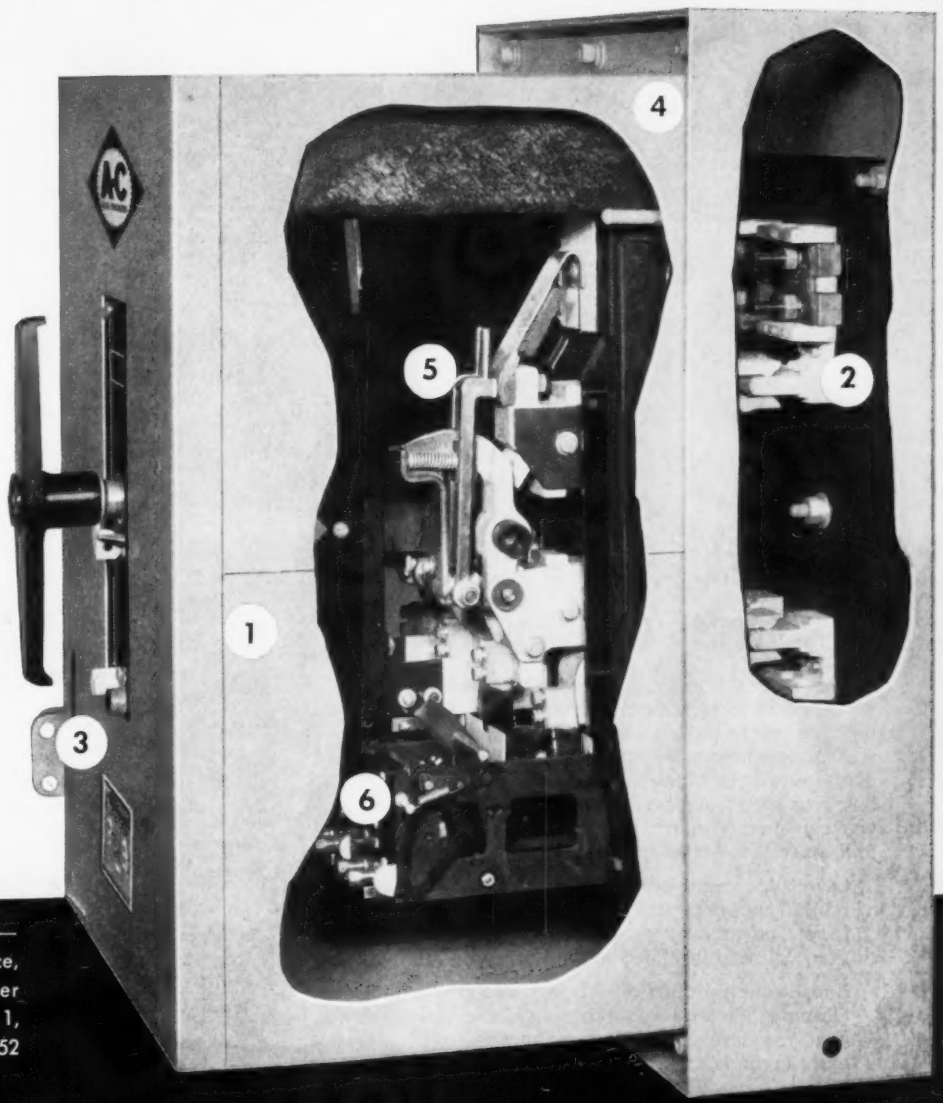
3. Safety Interlock — Prevents removal of cover while breaker contacts are closed.

4. Enclosures to meet your needs — Weather-proof or dust-proof as well as standard general purpose enclosures are available.

5. Long life contacts — There's no bounce—less erosion — due to high contact pressure with blow-on type action.

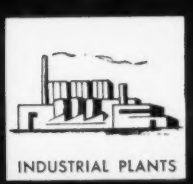
6. Accurate time-delay control — Hermetically sealed, positive displacement trip device is used.

For service to 600 volts ac, 1600 amperes continuous, 50,000 RMS amperes interrupting at 600 volts ac.



Get details, dimensions, prices — Contact your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for Bulletins 18B8252 and 18B8283.

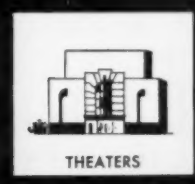
PUBLIC BUILDINGS


INDUSTRIAL PLANTS

UTILITIES

ATHLETIC FIELDS

BUSINESS PLACES


THEATERS

ALLIS-CHALMERS

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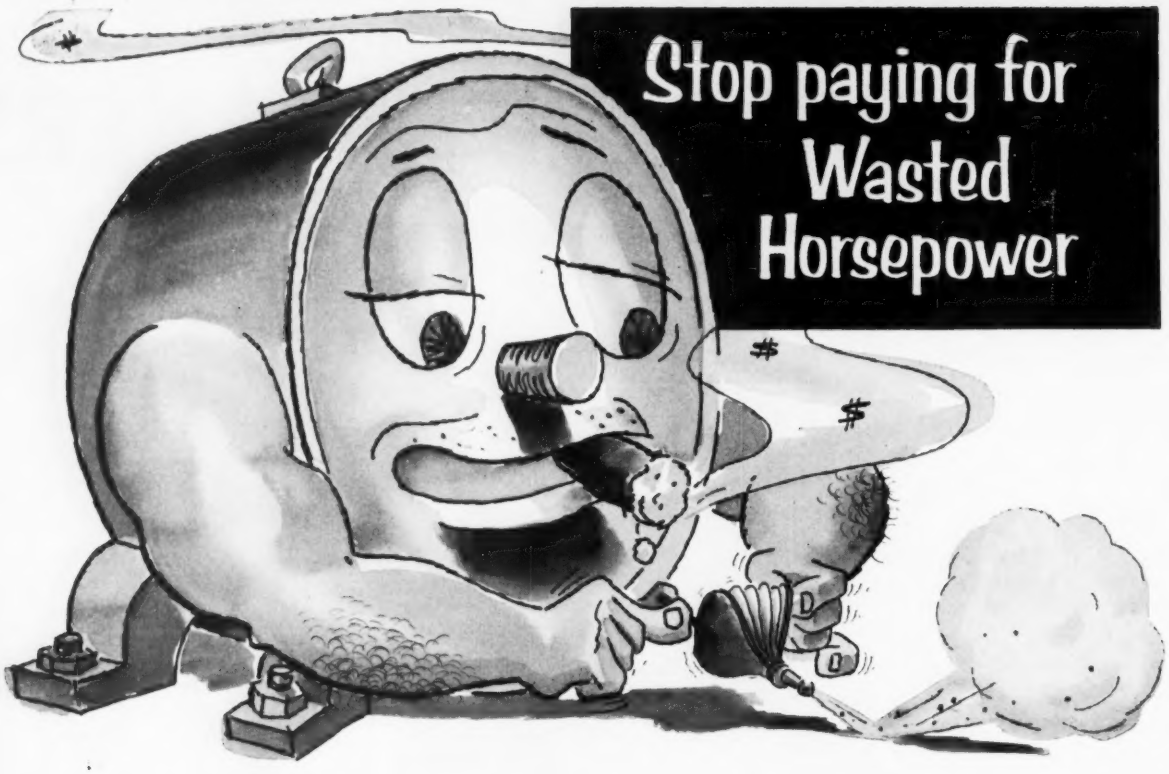

Stop paying for Wasted Horsepower

Just match your average load . . . let silicones carry the overloads

If you specify horsepower to equal "peak overloads," your motors work at full rated capacity only part of the time — you're paying for unused horsepower. Today, silicone insulation has outmoded this kind of wasteful over-motoring. Motors insulated with Dow Corning Silicones have a service factor of 25 to 50% . . . so now you can merely match your average load, and let this *built-in* service factor handle intermittent overloads.

Lower your motor costs! For every dollar wasted on unused motor capacity, you spend an additional $3 for starters, cable, transformer capacity and installation. Silicone insulated motors *save* you real money!

Boost your production! Motors insulated with Dow Corning Silicones have much greater resistance to heat, moisture, and corrosive atmospheres . . . assure *more continuous production.*

Remember, over-motoring is outmoded

Get sources for silicone insulated equipment—mail coupon today

Dow Corning Corporation, Dept. 6914, Midland, Mich.

Please send me sources for Silicone insulated
☐ Motor ☐ Transformers ☐ and Reprint
"New Developments in Silicone Insulation."

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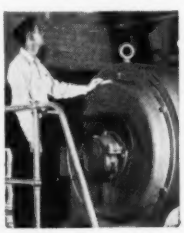
Here's more proof for you...

The Philip Sporn plant on the American Gas and Electric System installed its first silicone insulated motor over 6 years ago . . . a 1000 hp, 1190 rpm forced draft fan motor built by the Elliott Co. Smaller and less costly to install than an equivalent 1500 hp conventional motor, this unit has been operating in ambient temperatures up to 120 F without a sign of failure to date. Starting against cold air 4 times a day, it is overloaded by 30% bringing its total rise to 250 F with an output of 1300 hp. This kind of dependable performance has led American Gas and many other leading utilities to standardize on silicone insulated auxiliary motors.



DOW CORNING SILICONES

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New RIDGID 4PJ Geared Threader Is Now

*JAM-PROOF

*Automatically Stops Threading When Standard Length Thread Is Cut

Power drive threading is safe and easy with this new 4PJ—no more watching of either die stock or drive! 4PJ can't jam—drive pinion kicks out automatically when full thread is cut. Extra-easy to handle ...mistake-proof workholder, no bushings... fully enclosed gears... RIDGID most-for-your-money—Buy new 4PJ at your Supply House!

← RIDGID 400A Power Drive with Universal Drive Shaft operates 4PJ Threader on 4" pipe held in Tristand Chain Vise, all RIDGID products.

RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company, Elyria, Ohio, U.S.A.

USERS SAY R/M RUBBER PRODUCTS GIVE

Ray-Man Conveyor Belt... Lower Cost per Ton Carried

Cushioned strength members . . . with double compensation to relieve stress on outer plies . . . give Ray-Man Conveyor Belt unusual flexibility to permit fuller loads . . . even where relatively thick, narrow belts are used . . . or where pulleys are small. Holds fasteners under the most severe conditions. No breaker ply required. Use of newest synthetic super-strength fibers insures even greater service than ever before. Like all R/M heavy duty conveyor belts, Ray-Man is moisture resistant . . . mildew-proof . . . and protected against wear, tear, cuts and abrasions with R/M's exclusive and remarkably tough "XDC" Cover. Ray-Man cuts handling costs because it does a bigger job, better . . . and *lasts longer*.

Write for Bulletin #6915

● TRAINS NATURALLY

● RESISTS IMPACT

● DOUBLE COMPENSATION RELIEVES OUTER PLY STRESSES

Ask an R/M representative how these features of Ray-Man Conveyor Belt add up to lower cost per ton handled . . .

"More Use per Dollar"

YOU "*More Use per Dollar*"

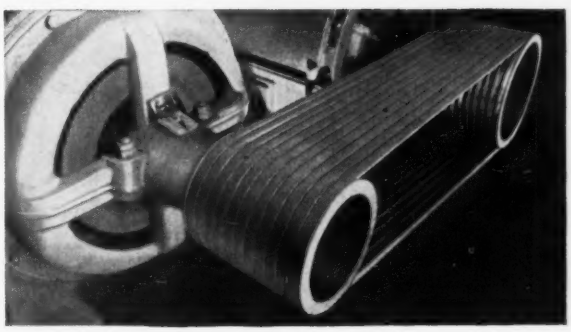
R/M Poly-V® Drive Delivers More Power in *Less Space!*

Unique patented design accounts for the extra power capacity of R/M Poly-V* Drive. A single, endless belt, with lengthwise parallel V-ribs running on sheaves designed to mate precisely with the belt ribs gives Poly-V high V-groove *grip* . . . *plus* flat belt *strength* . . . *twice* the tractive surface to deliver more power than ever before possible! Narrower sheaves can deliver *equal* power in as little as ⅔ the space required for a conventional V-belt drive . . . or up to 50% *more* power in the *same* space! This means *less* shaft overhang . . . *less* drive weight . . . *less* bearing load.

Poly-V eliminates multiple-belt "length matching" problems. Inventories of belts and sheaves are cut because just *two* belt cross sections meet every heavy-duty requirement.

The engineers who developed Poly-V Drive are prepared to work with you to determine the installation best suited for your heavy duty power transmission requirements. Contact an R/M representative...or write for R/M Poly-V Bulletin #6638.

**Poly-V is a registered Raybestos-Manhattan trademark.*



R/M Super-Power and Condor V-Belts ...the Smoothest Running V-Belts Made!

Straight sidewalls on these V-belts provide more grip, less slip, *longer* trouble-free performance. You can get up to 40% greater hp capacity with R/M Super-Power V-Belts as compared to standard types . . . or do an equal job with fewer belts!

Write for Bulletins

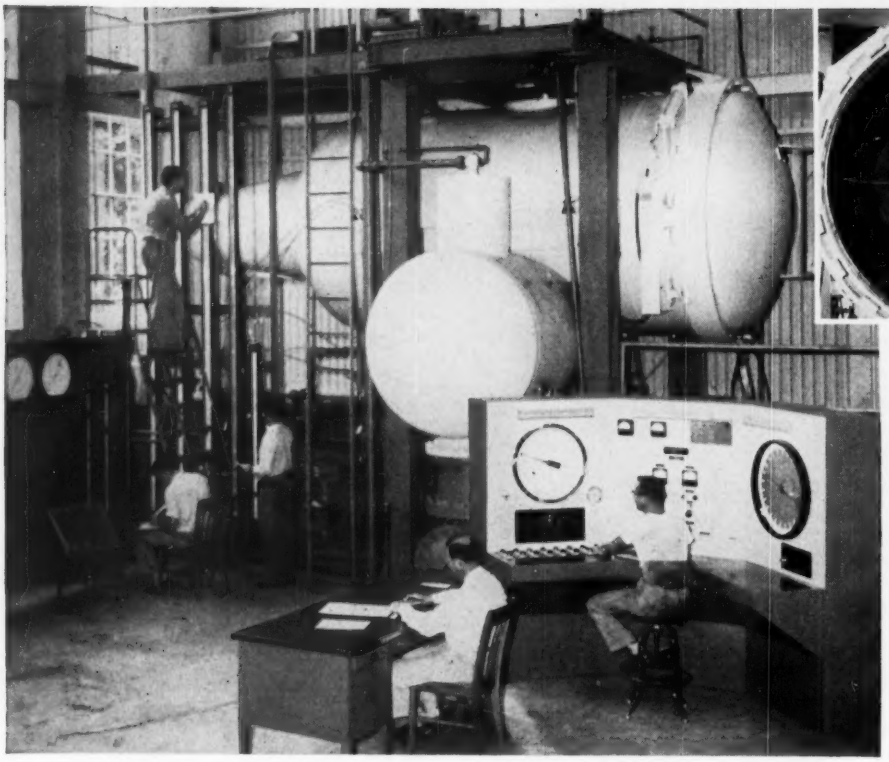
RM-701R

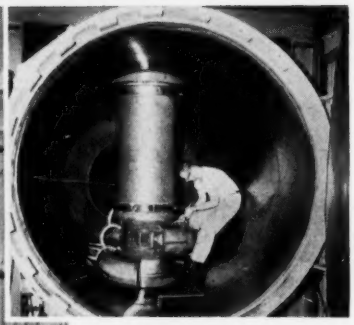
BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls





A complete model turbine wheel case assembly, built to extreme accuracy, is shown being mounted in the testing chamber.

New high head test stand in the SMS Hydraulic Laboratory, including control panel and gages.

High Head Turbine Test Stand At SMS Laboratory DUPLICATES FIELD CONDITIONS

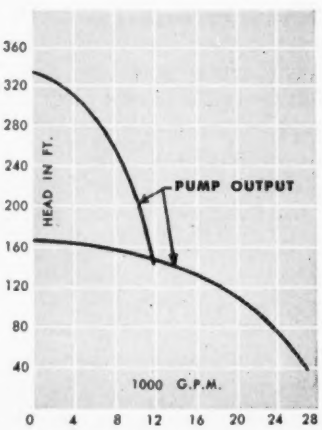
With the addition of its new high head test stand, the SMS Hydraulic Laboratory can now test homologous model turbines under controlled conditions that *duplicate* those found in the prototype installations. This is a substantial stride forward in hydraulic turbine research, since the complete reproduction of actual field conditions has not previously been possible.

The outstanding features of this new facility are:

- World's highest artificial testing head.
- Flows of 5,000 g.p.m. under 300-foot head, and 21,000 g.p.m. under 100-foot head.
- 300 H.P., 0 to 6,000 R.P.M., eddy current dynamometer.
- 100-ton water cooling system to maintain prototype water temperature.

Both basic research and formal contract acceptance tests are performed here. Test stand equipment permits testing of all Kaplan and Propeller, as well as many Francis turbine designs, under conditions of *head* and sigma that *duplicate* those found in the field. This provides a high degree of testing accuracy and permits accurate testing of settings that cannot be satisfactorily field tested.

For further information on the significance of this high head test stand, write to S. Morgan Smith Co., York, Pa.



Pump Head-discharge Curves for Series and Parallel Operation.

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

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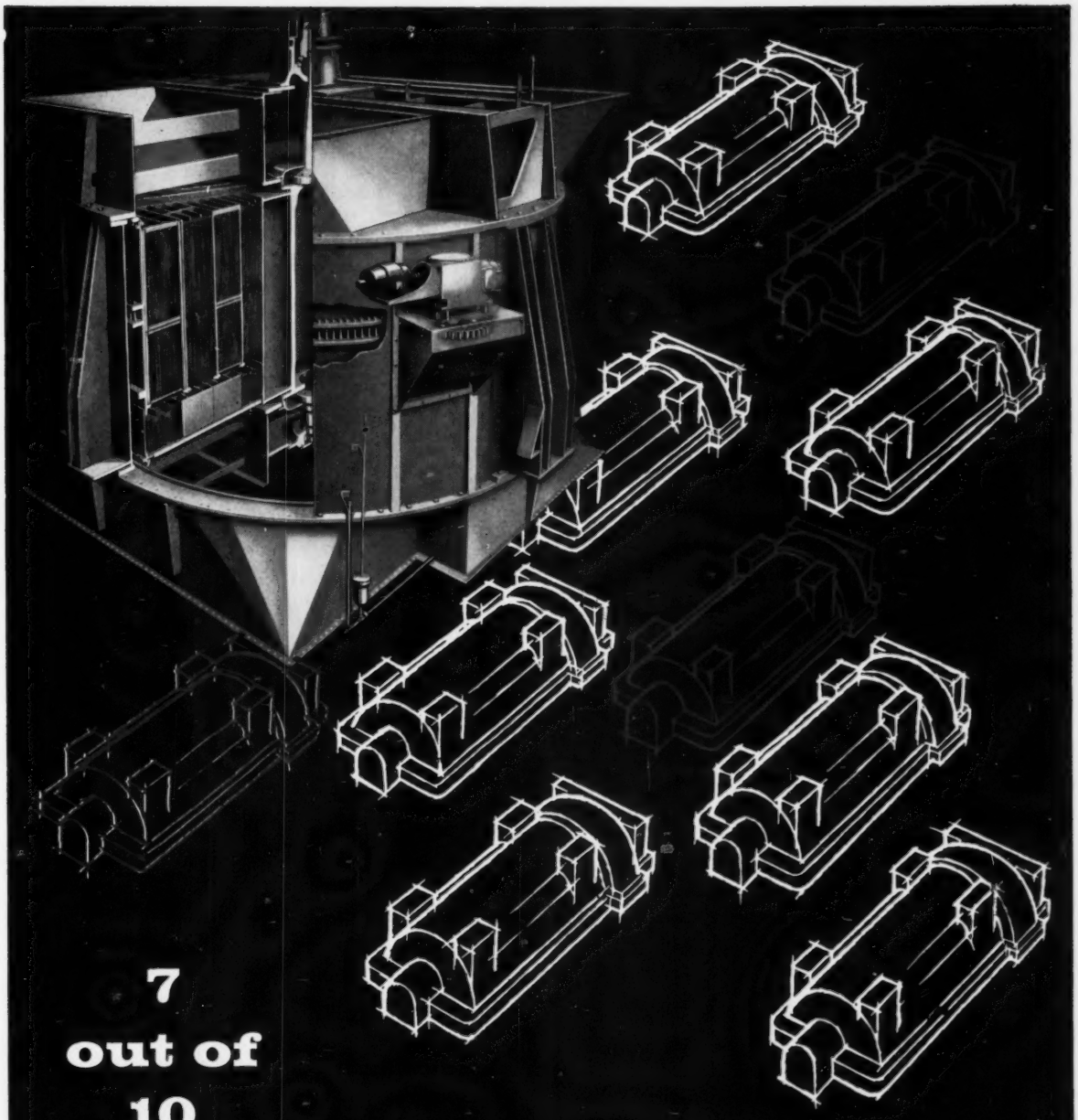
BUTTERFLY VALVES
FREE DISCHARGE VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS



7 out of 10

air preheater installations are Ljungstrom®

Advantages of the Ljungstrom Air Preheater

- Size for size, recovers far more heat than any other type.
- Reduces fuel consumption. Permits use of lower grade fuels. Increases boiler output and reliability.
- Eliminates cold spots . . . keeps corrosion to a minimum.
- Easier, faster to clean and maintain.
- Requires far less supporting steel and is quickly erected.

MINIMUM MAINTENANCE is one of the many important reasons. More complete combustion of fuel results in far less slagging, and gases entering dust-recovery units are cleaner. There's less corrosion. Insertion of new elements can be done in as short a time as four hours. You can even inspect the Ljungstrom through a built-in port while the unit is in operation.

For the interesting full story, send for a free copy of our 38-page manual.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

POWER FROM THE ATOM IS READY TODAY

ALCO's pressurized-water plant offers safe, stable power to 20,000 kw for high-cost fuel areas

Basic design and engineering for the ALCO atomic plant are complete. Experience with the Army Package Power Reactor — built by ALCO under the first fixed-price contract for a plant awarded by the AEC — has contributed to the commercial plant design. Because of this, the plant is not experimental. It can provide economical power in remote areas where fossil fuels are expensive. And ALCO's own criticality facility will make tests on specific reactors to insure their performance — before they reach the plant site.

Investigate the ALCO atomic plant. Technical analysis is available, at no obligation, on site selection, design specifics and operating costs.

ALCO nuclear components result of experience, leadership

ALCO's leadership in thermal engineering and manufacturing has produced atomic plant components for almost all reactor types. ALCO has designed and built components for the *Nautilus*, the APPR, sodium reactors and various AEC production installations. Along with this extensive experience, ALCO has complete facilities to insure continued leadership. These include its new thermal laboratory, mechanical, welding and metallurgical laboratories, criticality facility, and an electronic-computer center for thermal, mechanical and nuclear problems.

Here is a list of ALCO atomic plant components that are available:

reactors • reactor vessels • control-rod drive mechanisms • steam generators pressurizers • core-support structures • core removal and handling equipment regenerative and non-regenerative exchangers • liquid metal exchangers decay exchangers • special heat-transfer equipment.

For information, including the brochure "Competitive Power from the Atom," write Atomic Projects, Dept. AE-1, P.O. Box 1065, Schenectady 1, N. Y.

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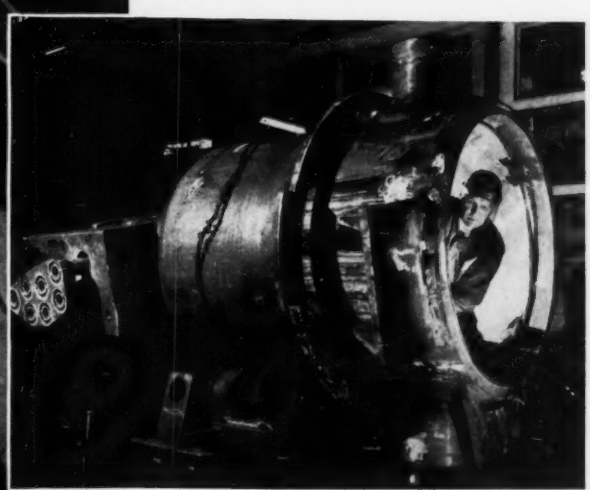
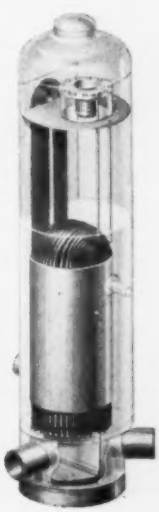
ALCO PRODUCTS, INC.
NEW YORK
Sales Offices in Principal Cities

Locomotives • Diesel Engines • Nuclear Reactors • Heat Exchangers
Springs • Steel Pipe • Forgings • Weldments • Oil-Field Equipment

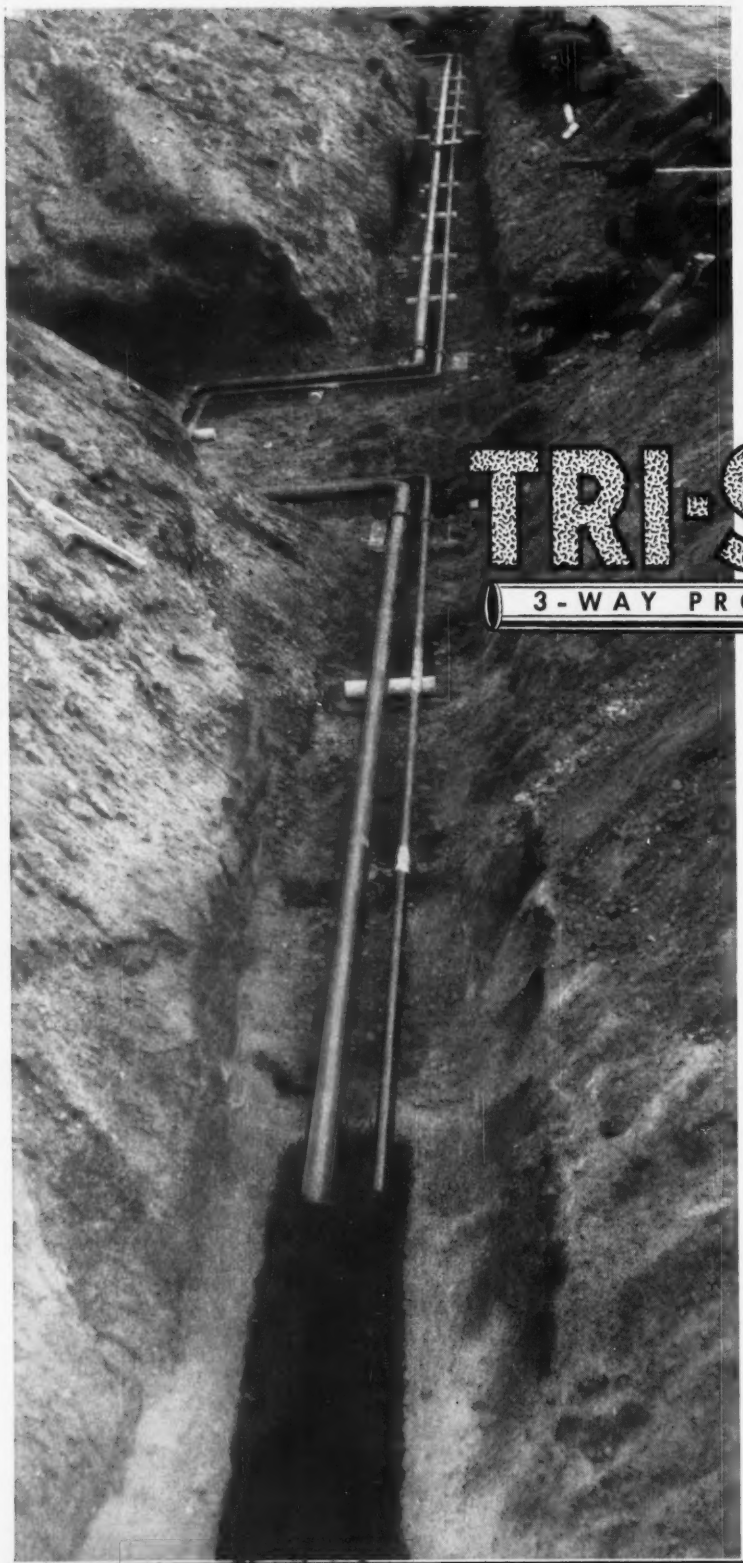


Reactor vessel for APPR was built of stainless steel at ALCO's Dunkirk, N. Y. plant.

Cutaway of ALCO steam generator for pressurized-water atomic plants.



Technician checks APPR reactor core prior to tests in ALCO's criticality facility at Schenectady, N. Y.



lowest capital outlay for complete hot underground pipe protection

TRI-SUL-ITE

3-WAY PROTECTION SYSTEM

Yes, a *single, adhering* material, TRI-SUL-ITE, provides complete 3-way protection for hot underground pipes.

TRI-SUL-ITE is a specially selected, high quality Gilsonite. You pour and work it around and under the pipes, then lightly tamp. Simple curing by proper pipe heat converts TRI-SUL-ITE into an efficient 3-zone protective barrier against water, corrosion and heat loss.

ZONE 1, adjacent to and adhering to the pipe, consists of completely fused TRI-SUL-ITE. This zone is a permanent water barrier. It prevents water from following the grade of the pipe.

ZONE 2 consists of partially fused TRI-SUL-ITE granules—an efficient insulator.

ZONE 3 consists of unfused TRI-SUL-ITE granules. This zone resists water penetration, and is an excellent insulator. It also cushions shocks and stresses.

TRI-SUL-ITE is readily adaptable to future pipe changes. Old material can be quickly removed and new material installed as simply as before, without jeopardizing the original installation.

Write to Dept. P for brochure and installation procedures

G. S. ZIEGLER & COMPANY

GENERAL OFFICES

GREAT NECK, N. Y.

MINES: "CASTLE PEAK," "LITTLE BONANZA," "LITTLE EMMA" • PROCESSING PLANTS: CRAIG, COLO., PROVO, UTAH

ZCO

R.S.M.
Design features like these help Edward sell more steel non-return valves than any other manufacturer in the world.
B.J.B.

ROCKWELL BUILT
Edward Valves

Edward Impactor handwheel seats big valve tightly—allows one man to do the job of three.

Patented Ewalthrust bearing construction eases operation, reduces stem drag.

Streamlined body really helps. Pressure drop is only about half what it might be. Edward makes streamlined angle non-return valves too.

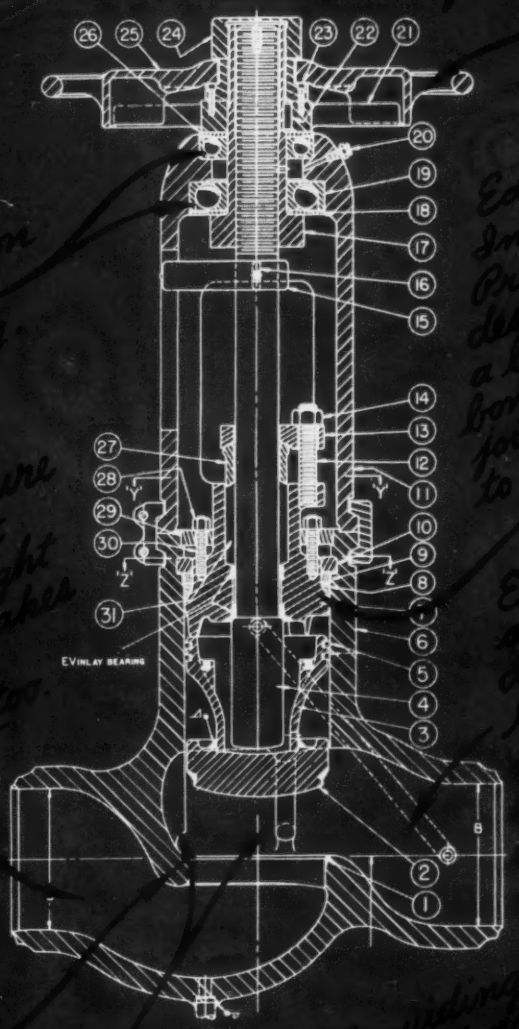
Integral stellite seat is last. Only Edward has it on large valves.

Edward Improved Pressure Seal design makes a leak proof bonnet body joint, is easy to disassemble.

Equalizer aids disk-piston lift; reduces motion and extends life of guiding surfaces.

Full length rib guiding of disk provides perfect alignment, insures true seating and reduces danger of hang ups.

When it comes to steel non-return valves, let's order Edward and have them quote on other valves too.



LIST OF MATERIALS
QUANTITIES ARE FOR ONE VALVE
WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES

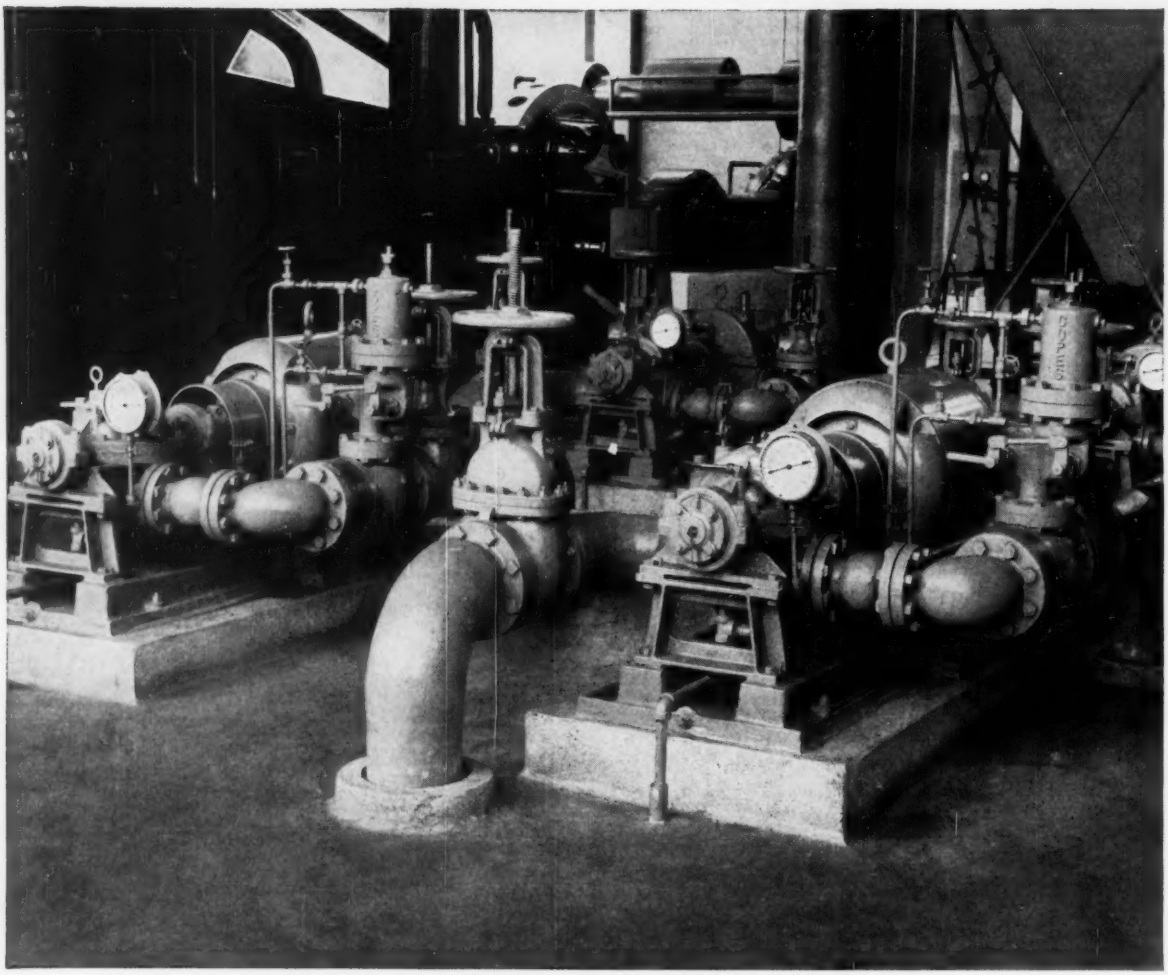
PIECE NO.	NAME OF PIECE	NO. REQ'D.	MATERIAL	SPECIFICATIONS	TENSILE PSI MIN.
1	SEAT		STELLITED	INTEGRAL WITH BODY	90,000
2	DISK	1	FORGED ALLOY STEEL STELLITED	CLASS A NEC GRADE F11	125,000 to 140,000
3	PISTON WELDED TO DISK	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	70,000
4	GUIDE	1	EVINLOY	A.S.T.M. A296, GRADE CF8	75,000
5	PISTON RINGS	2	EVINLOY	A.S.T.M. A296, GRADE CF8	75,000
6	BODY	1	CAST STEEL, C-0.35 % MAX. CAST STEEL, C-0.30 % MAX. CAST STEEL, CARBON MAX.	A.S.T.M. A216, GRADE WCB A.S.T.M. A216, GRADE WCB A.S.T.M. A216, GRADE WCB	70,000 70,000 70,000
7	BONNET	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	70,000
8	PRESSURE SEAL GASKET	1	ARMCO IRON	MALLEABLE, ANNEALED	50,000
9	SPACER RING	1	STEEL		
10	GASKET RETAINER	1	EVINLOY	A.S.T.M. A182, GRADE F8	85,000
11	YOKE	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	70,000
12	PACKING STUDS	2	STEEL, B. & S.	A.S.T.M. A193, GRADE B7	105,000
13	GLAND FLANGE	1	STEEL, PLATE	A.S.T.M. A212, GRADE B	70,000
14	GLAND BOLT NUTS	2	STEEL	A.S.T.M. A194, GRADE 2H	124,000
15	HEX. SOC. SCREW	2	STEEL, PLATE	A.S.T.M. A182, GRADE F8	85,000
16	STEM SUNK KEY	1	STEEL	SAE, NO. 1020	
17	YOKE BUSHING	1	CAST BRONZE	A.S.T.M. B-148 GRADE 9A-C.D.A.	450
18	BEARING WASHER	1	STEEL, GALVANIZED	A.S.T.M. A-575, GRADE B	115,000
19	ANGULAR CONTACT BALL BEARINGS			S.A.E. STANDARD	
20	ALEMITE FITTING	1	PISTON HEAD, INDUSTRIAL TYPE		
21	CROSSARM	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	70,000
22	CROSSARM KEY	1	STEEL	A.S.T.M. C1018	70,000
23	HANDWHEEL BUSHING	1	BRONZE	A.S.T.M. B-61	37,000
24	HANDWHEEL LOCKNUT	1	STEEL, PLATE	A.S.T.M. A-572, GRADE B	115,000
25	IMPACTOR HANDWHEEL	1	CAST IRON	A.S.T.M. A126, CLASS A	30,000
26	BEARING WASHER	1	STEEL, GALVANIZED	A.S.T.M. A-575, GRADE B	115,000
27	STUD	2	STEEL	A.S.T.M. A-193, GRADE B7	125,000
28	BONNET RETAINER NUTS	6	STEEL	A.S.T.M. A-194, GRADE 2H	124,000
29	BONNET RETAINER RING	1	STEEL, PLATE	A.S.T.M. A-212, GRADE B	70,000
30	BONNET RETAINER STUDS	6	ALLOY STEEL	A.S.T.M. A-193, GRADE B7	125,000
31	PACKING RINGS		HIGH TEMPERATURE PACKING		

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

EDWARD GLOBE NON-RETURN VALVE
PRESSURE SEAL BONNET — WELDING ENDS
GENERAL ASSEMBLY

DRAWN		DRAWING NO.
CHK'D		AE-3213-6
APP'D	DATE:	



"Buffalo" Type RR Pumps on boiler feed at a large auto plant

"BUFFALO" – THE PUMPS THAT DON'T MIND BEING IN HOT WATER AND UNDER PRESSURE!

In selecting boiler feed pumps of both peak efficiency and year-after-year durability, under pressure, pick the make with the 80-year record for these characteristics — "Buffalo". This long experience in designing and building centrifugal pumps for industry has resulted in present-day "Buffalo" Pumps with every feature for maximum delivery at least power input — and for continuous service with negligible maintenance.

"Buffalo" Type RR two-stage and four-stage pumps have the typically efficient, balanced "Buffalo" impellers — the oversize bearings and shafts — the rugged casings with simply formed water passages and deep 8-ring stuffing boxes. Write for Bulletin 980 and see why we say there's no better buy!

Boiler feed pumps for pressures to 500 psi

BUFFALO PUMPS
Division of Buffalo Forge Co.
488 BROADWAY, BUFFALO, N. Y.
Canada Pumps, Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

"Buffalo"

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

J. R. P.
Here is an inexpensive, rugged forged steel valve that is quality-controlled to meet the highest standards
E. B. J.

ROCKWELL BUILT
Edward Valves

Large size knobbed handwheel eases operation.

Deep, full-size stuffing box and Evalpak packing combine to minimize maintenance.

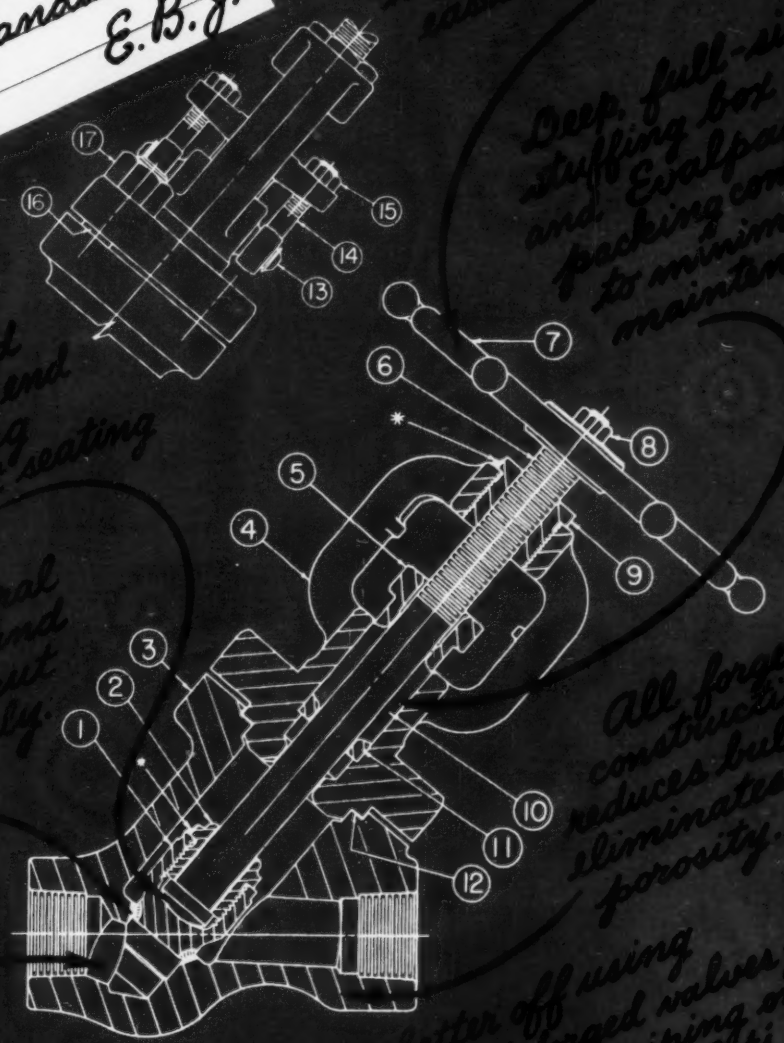
Swivel disk and radiused stem end prevent galling insure perfect seating

Edward integral Stellited seat and Stellited disk cut repairs sharply.

Straight through flow minimizes turbulance and pressure drop.

All forged construction reduces bulk-eliminates porosity.

We'll be better off using Edward forged valves for all small piping on our job. Let's get a bid.



LIST OF MATERIAL
QUANTITIES ARE FOR 1 GLOBE OR 1 ANGLE VALVE
WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES

PIECE NO.	NAME OF PIECE	NO. REQ'D	MATERIAL	SPECIFICATIONS	EDWARD MS NO.
1	DISK	1	FORGED ALLOY STEEL STELLITED	A.S.T.M.A182 GRADE F11	227 483
2	DISK NUT	1	STEEL	A.I.S.I. C1120	123
3	BODY	1	FORGED STEEL (a)	A.S.T.M. A105, GRADE II	111/483
			FORGED STEEL (b)	A.S.T.M. A182, GRADE F11	227/483
4	BONNET	1	FORGED STEEL (a)	A.S.T.M. A105, GRADE II	111
			FORGED STEEL (b)	A.S.T.M. A182, GRADE F11	227
5	GLAND	1	MALLEABLE IRON	A.S.T.M.A220, GRADE 53004	324
6	STEM	1	EVALLOY	A.I.S.I. GRADE 416	261
7	HANDWHEEL	1	MALLEABLE IRON	A.S.T.M.A47 GRADE 32510	322
8	STEM NUT	1	STEEL	A.S.T.M.A194 - GRADE 1	124
9	YOKE BUSHING	1	BRONZE	A.S.T.M. B62	412
10	PACKING RINGS		EVALPAK	HIGH TEMPERATURE PACKING	501
11	JUNK RING	1	STEEL - EVALIZED	A.I.S.I. C1120	123
12	BONNET GASKET	1	IRONKOTE		505
13	GLAND BOLT WASHER	2	STEEL		
14	GLAND BOLT	2	FORGED STEEL EVALIZED	A.S.T.M. A105, GRADE II	111
15	GLAND BOLT NUT	2	STEEL - EVALIZED	A.S.T.M.A194 - GRADE O	125
16	TAP END STUD	4	ALLOY STEEL (c)	A.S.T.M.A193	
17	BONNET STUD NUT	4	STEEL (c)	A.S.T.M.A194 -	

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

FORGED STEEL
GLOBE AND ANGLE VALVES

DRAWN		DRAWING NO
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Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

for cooling tower application...

There's MORE protection against humidity in Allis-Chalmers MOTORS

The ultimate in protection against high humidity — major cause of cooling tower motor failure — is provided tower builders and users in Allis-Chalmers TEFC motors. Here's why:

1. **Moisture drainage** — Drain plug can be removed to eliminate condensed moisture in the motor. (Particularly helpful in intermittent operations where condensation is more likely.)

2. **Extra-insulated stator** — Several applications of special insulating varnish plus repeated baking keep humidity out . . . give the long electrical life you need.

3. **Weather-protected bearings** — Rotating seal, turning in close running clearances, guards against entry of water.

Find out more about the "MORE" in Allis-Chalmers motors by contacting your nearby A-C sales office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

Outdoor Installation on jacket water-cooling units is ideal for Allis-Chalmers motors. Cast-iron frame and conduit box aren't affected by weather.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5183

Unretouched photo shows what happens when a boiler feed line is clogged with calcium carbonate deposits. CAUSE: *lack of chemical stability in feed water.* REMEDY: *properly balanced water treatment.*

LINE OF MOST RESISTANCE

A heavy build-up of scale, like that shown in the illustration, will gradually reduce the effective diameter of feed line piping, and will result in seriously restricted carrying capacity.

The line must be shut down for maintenance or replacement, causing expensive down time in the plant. Proper water conditioning will prevent this unnecessary loss. This is but one of the many problems presented by the corrosive elements of water.

In Dearborn's complete line of water conditioning products, there are treatments to eliminate scaling, sludge, carry-over, return line corrosion and other similar difficulties. Dearborn combines the proper treatment with the right control methods under technical supervision. The result: less down time and greater operating efficiency.

Dearborn Supervisory Service provides you with the three elements necessary to maintain the best in a water conditioning program—positive control, top performance effectiveness and maximum economy.

Mail the coupon for complete information.

Dearborn®

... a leader in water conditioning and corrosion control for 70 years

Dearborn Chemical Company
Merchandise Mart Plaza, Dept. PO, Chicago 54, Ill.

Gentlemen: ☐ Send my copy of Dearborn Water Conditioning Program.
☐ Have a Dearborn Water Treatment Engineer call.

Name.....*Title*.....

Company.....

Address.....

City.....*Zone*.....*State*.....

YOU CAN COUNT ON KEWANEE-ENGINEERED PRODUCTS

his assignment:

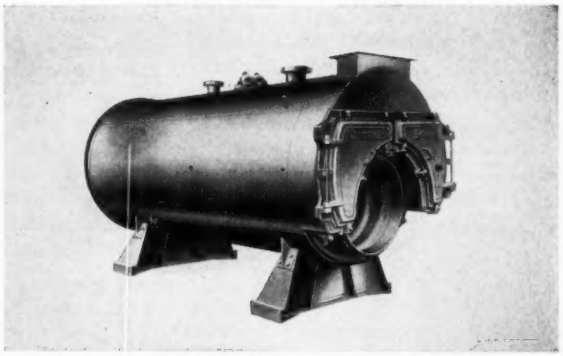
TO HELP YOU FORGET

Kewanee Boilers are advertised to your clients regularly in national publications.

Helping you avoid, solve and *forget* your clients' heating or power problems is the prime assignment of your Kewanee man. He's trained for it, experienced in it—a qualified boiler specialist with the data you need, the knowledge you value.

And his catalog carries the exact size and type of boiler you need for any requirement from 70,000 btu's for a small home up to 651 h.p. for an industrial plant. Every unit fulfills the nation-wide Kewanee reputation for efficiency, fuel economy, low maintenance and long life . . . backed by 89 years of experience.

Kewanee men serve you from a coast-to-coast network of Kewanee Branch Offices. A telephone call brings the nearest one to work with you. American-Standard, Kewanee Boiler Division, 101 Franklin Street, Kewanee, Illinois.



When boiler room space is limited, this Kewanee M-800 Series is an ideal source for 15 lbs. steam or 30 lbs. water or high pressure steam 125 lbs. and up.

AMERICAN-Standard

KEWANEE BOILER DIVISION

LOUIS N ROWLEY, EDITOR • FEBRUARY 1957 • ESTABLISHED 1882 Power

Your Big Electrical Job

DURING the week of February 10, you're going to hear a lot about electricity. That's National Electrical Week, designed to ". . . focus attention on the contributions of electricity to our American way of life . . ."

We'd like to do some of that focussing right here. As power-service engineers, we know that electricity is one of the great foundations on which efficient production is built. We know, at first hand, how this infinitely versatile form of energy puts muscle into every part of the great and growing American economy. And we know there's a job waiting to be done if all industry is to have the *power to grow . . . electrically.*

Stated in simplest terms, that job is to gear industrial electrical systems to the demands a dynamic future will bring. And the blunt fact is that right now, in all too many plants, production expansion is being hampered by inadequate electrical facilities. Many more will soon feel the pinch. Included in these will be some new or modernized plants where shortsighted planning has failed to provide capacity and flexibility to meet load growth economically.

Of necessity, these problems will be solved. Future loads will be met, but, in too many cases, by expensive, cumbersome, piecemeal tearing out and rebuilding of the electrical system. So why wait until the problem reaches such a pitch? Action *now* can avoid these costs and delays, provide instead for smooth, economical handling of the heavier loads that tomorrow is sure to bring.

The action we refer to, of course, is the *power-to-grow* planning we have been advocating in our current editorial program. As these articles make abundantly clear, the key idea is to build into the electrical system the ability to expand economically. This ability to expand economically is measured by the *power-to-grow* (PTG) index.

Building a high PTG index into your electrical system is mainly a matter of planning ahead; initial cost need be only slightly higher than for a system with a low PTG index. Then, by virtue of an initial investment of thought and a few extra dollars, you can reap savings in time and money when you make later additions to take care of load growth as it develops.

Such PTG thinking comes naturally to power-service engineers. Fully explained, it should look mighty attractive to top management men concerned with the problem of developing ever greater and more efficient productive capacity. To do this explaining job, you need to know, and be convinced of, the values of *power-to-grow* planning. And you need examples of what it has done for others.

POWER's PTG series is intended to help you along these lines: (1) to show how to build PTG into each part of the in-plant electrical system, and (2) to give you ammunition to use in making your top management urgently aware of the need for *power to grow . . . electrically.* Use these articles to make sure your in-plant electrical system will be able to expand economically to keep pace with the growth of our dynamic economy.

"Heating in our switch was causing '*lights-out*' shutdowns until we changed to cooler operating Fusetron Fuses"

Thomas Lavin, Building Engineer
Railway Exchange Building
Denver, Colorado

Mr. Lavin Continues:

"We had considerable trouble with heat developing in a lighting switch and causing fuse blows. It was very annoying having the lights go out so often—and having regular maintenance work interrupted to replace fuses.

"Checking with an ammeter we found the continued load to be 28 ampere. This indicated that 30 ampere fuses in use were the right size for safe protection. Nevertheless, the renewable fuses we had installed kept blowing.

"Evidently, what we needed were the same size fuses that would operate cooler to eliminate heating in the switch.

"At the suggestion of a salesman we tried 30 ampere Fusetron dual-element fuses. Our heating problem immediately disappeared. This was 7 or 8 months ago and we have had no trouble with the switch overheating—and our—'lights-out' shutdowns are a thing of the past."

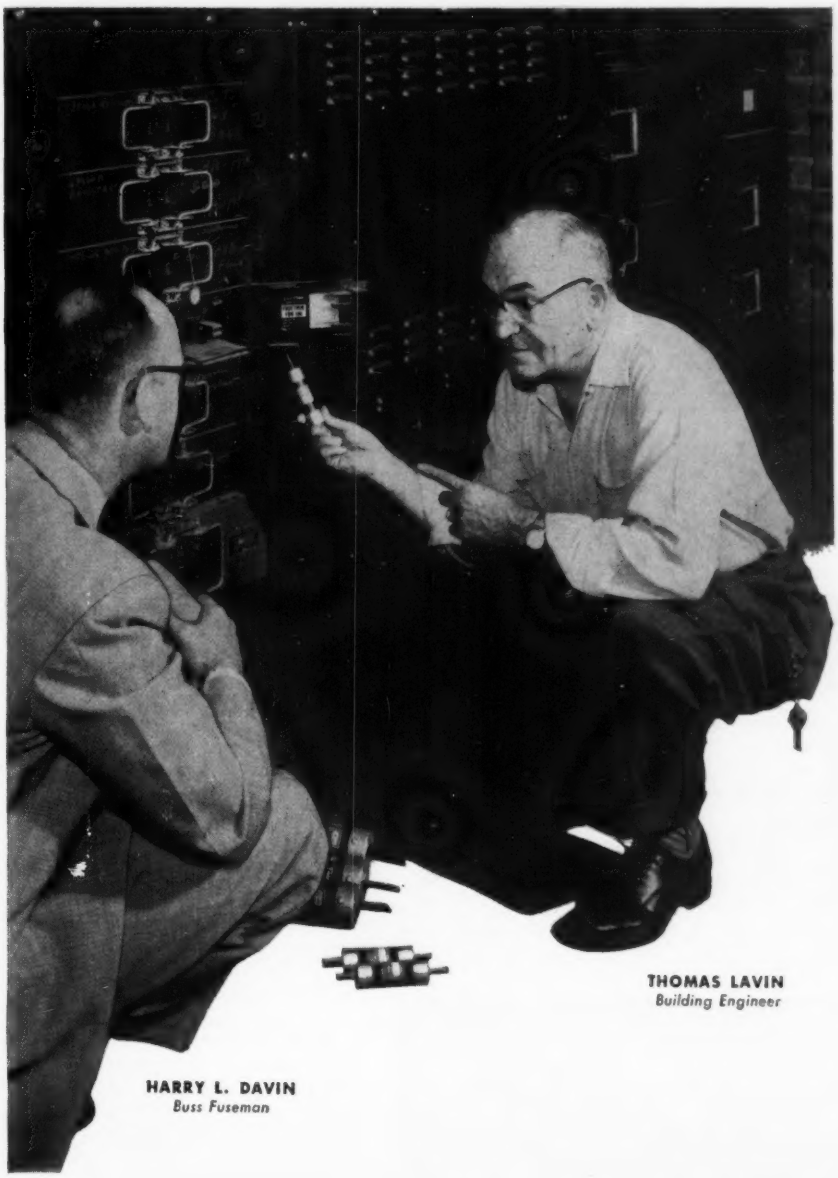
Here's why Fusetron Fuses protect against needless blows caused by excessive heating of panels and switches

Fuses, like other protective devices operate from heat created by the current flowing through them. Thus they produce some heat even in normal operation.

Sometimes the heat is not dissipated from switches and panels fast enough. This piled up heat over-heats fuses and reduces their carrying capacity. Then fuses often blow even though not loaded to their rated capacity.

A logical answer to this heating problem is the use of Fusetron fuses. Fusetron fuses produce less heat because they have less electrical resistance than ordinary fuses. For example, ordinary fuses have 55 to 117% greater resistance than Fusetron fuses in 250 volt sizes and up to 140% greater resistance for 600 volt sizes.

Since the lower resistance of Fusetron dual-element fuses means less generation of heat, switches and panels operate much cooler. This materially reduces or wipes out entirely useless shutdowns caused by fuses blowing due to overheating of panels and switches.



HARRY L. DAVIN
Buss Fuseman

THOMAS LAVIN
Building Engineer

Save time, trouble and money by using Fusetron dual-element Fuses.

THEY PROVIDE 10 POINT PROTECTION

1 High interrupting capacity—protect against heaviest short circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes. **2** Protect against needless blows caused by excessive heating—lesser resistance results in cooler operation. **3** Protect against needless blows caused by harmless overloads. **4** Provide thermal protection—for panels and switches against damage from heating due to poor contact. **5** Protect against waste of space and money—permit use of proper size switches and panels. **6** Protect motors against burnout from overloads. **7** Give DOUBLE burnout protection to large motors—without extra cost. **8** Protect motors against burnout due to single phasing. **9** Make protection of small motors simple and inexpensive. **10** Protect coils, transformers and solenoids against burnout.

Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5000 AMPS. — USE BUSS Hi-Cap FUSES!

They have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.

Play Safe! *install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!*

BUSSMANN MFG. CO.
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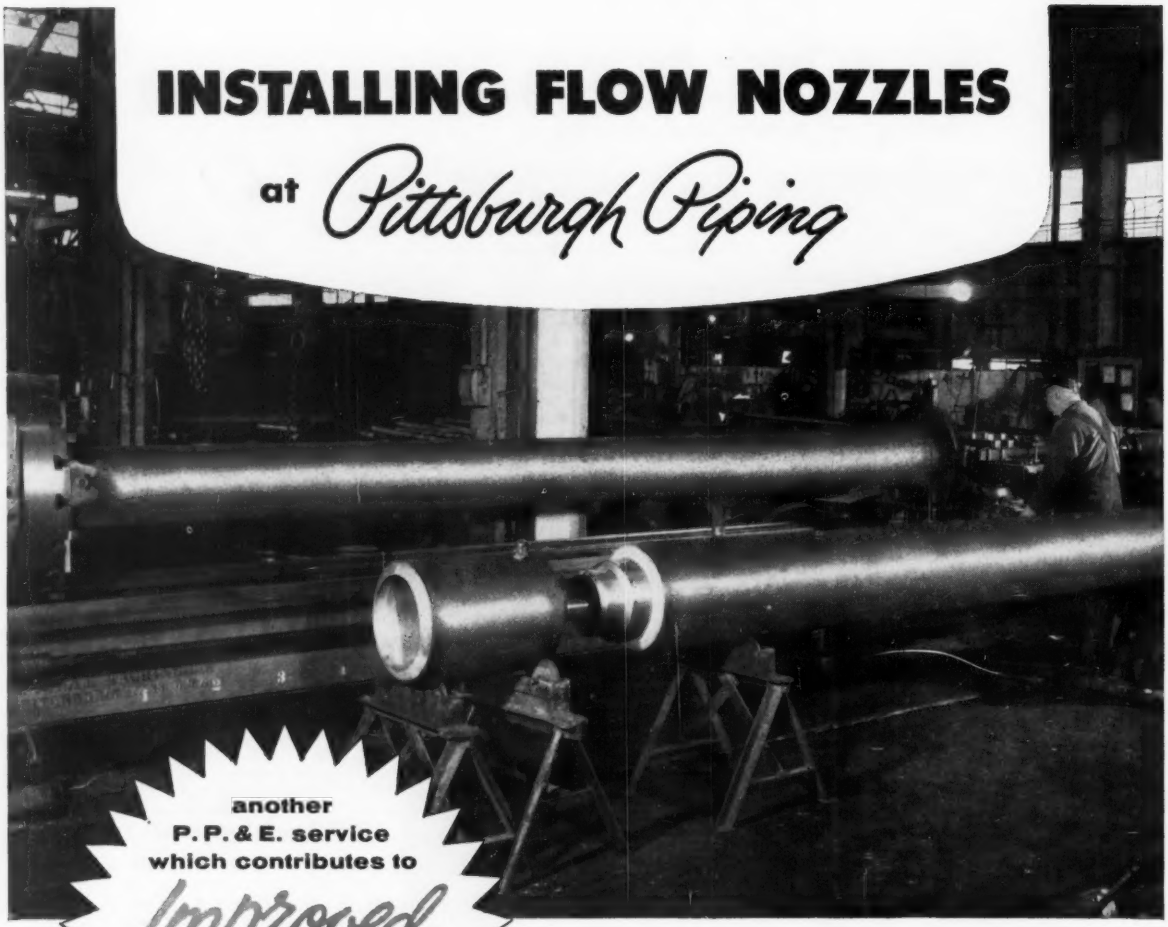
INSTALLING FLOW NOZZLES

at *Pittsburgh Piping*



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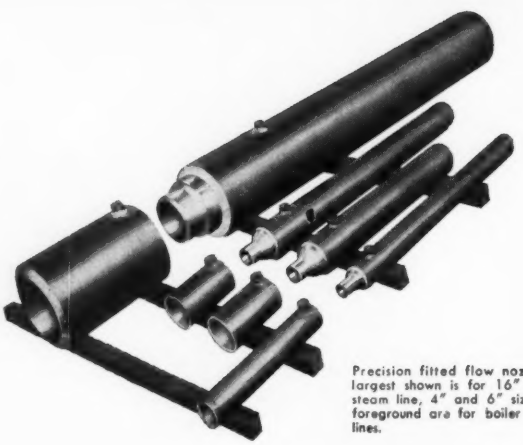
HIGH-PRESSURE
PIPING

Pittsburgh Piping's precision installation of flow nozzles in high-pressure piping is the result of extremely skillful machining, fitting, and welding by experienced craftsmen. This is another example of advanced techniques — available at Pittsburgh Piping — which provide greater safety, higher efficiency and longer life from high-pressure, high-temperature piping.



Precision fitted flow nozzles; largest shown is for 16" main steam line, 4" and 6" sizes in foreground are for boiler feed lines.

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PP-19

B G A SKROTZKI
Associate Editor in Charge

Power to grow ...electrically

No. 6: SECONDARY LOADING

With tomorrow's loads in mind, Kodak's electrical-engineering consultant J A Gienger comes up with...

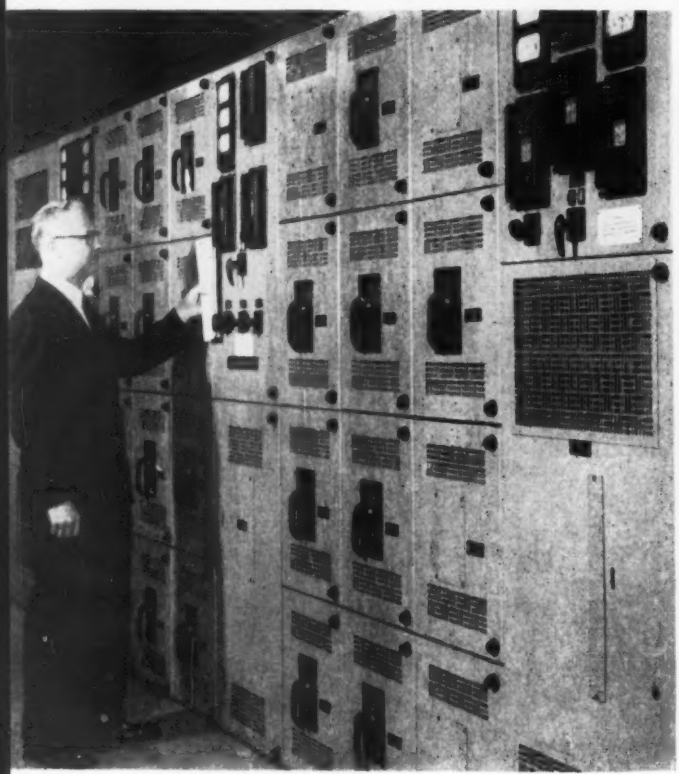
A 3-point PTG plan for secondary circuits

► MOST PLANTS TODAY do not have enough load to warrant a full primary-distribution system. But even the smallest industrial, commercial building or institution has a secondary scheme. It's in this large volume area, measured in number of plants, that growing need exists for PTG.

Kodak Park works in Rochester, N.Y. is selected as a case in point. Here basic PTG thinking is carried right down to the 480-v level. Expansibility and service continuity are musts in the Kodak operation. Sure, the technology of secondary-distribution design is developed to a fine art. But the stumbling block comes in economically injecting PTG thinking into each design.

Following pages present a boiled down version of the elements in equipment sizing and loading in the 480-v range. As emphasized in earlier articles of this series, power-to-grow planning doesn't call for a big initial capital investment. Your biggest investment *now* is planning—planning for growth that will pay off in the years ahead.

1 **Double-ended 2000-kva unit subs adopted, initially loaded to 50% full capacity**



2 **Feeders to area panelboards designed with a PTG index of 1.5**

The power-service engineer concerned with secondary distribution design must face up to current-carrying capacity, line losses, voltage drop and provision for future loads. Assuming he has a sound technical background, rounded off with practical field experience, the current handbooks plus manufacturers' catalogs should provide enough reference information on these scores.

Equipment size. The most economical long-range equipment size is often the stumbling block. On the secondary side of the electrical system, power men must consider size of substation, circuit breaker, secondary feeder, panelboard, conduit and cable tray.

If you worry simply about the most economical size to meet today's loads, the design problem is straightforward. The head scratching begins when you try to find the economical medium between barely adequate and over sizing. Take substations as an example.

Starting with the assumption that system circuit arrangements and substation voltage rating have been tied down, selection of kva size with lowest initial cost is largely a matter of matching actual design load conditions to a specific range of equipment sizes. In practice, three major elements affect overall system cost: *primary cable, secondary cable* and *substations.* And, in any plant, these elements buck one another costwise so you must look at all three. Here's why:

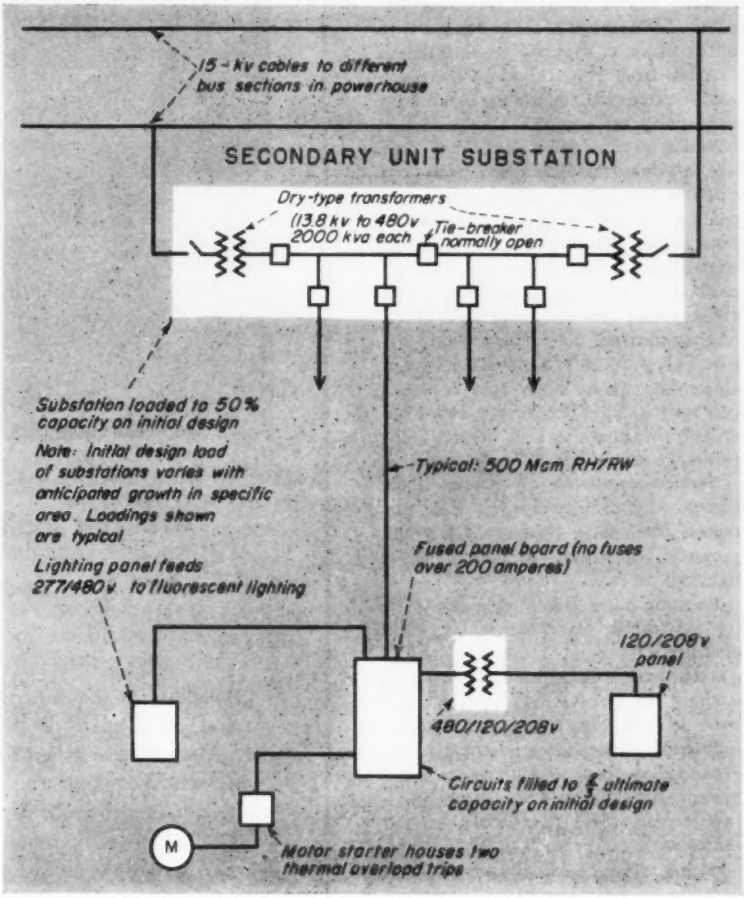
As you let the number of subs in a plant area increase, your primary-cable needs grow. Yet, at the same time, you require less secondary cable. And substation cost per kva varies depending on substation size. When all these factors are figured in a typical industrial plant, the most economical substation size generally runs about 750 kva for a 480-v system (POWER, Oct 1953, p 94).

Other angles must be considered. *Example:* Large spot loads sometimes justify larger subs. A single furnace, large welder or electric oven can justify subs in the 2500-kva range with a 480-v secondary. Where you run up against heavy spot loads, weigh the feasibility of two small subs rather than a single large one. This becomes more important when the number of secondary circuit breakers exceeds three.

But, in general, for most plant areas, two 1000-kva subs run up a lower overall system cost than a single 2000-kva unit. Likewise, a layout that uses two 750-kva subs proves less costly than one using a single 1500-kva unit. This holds true if necessary space is available. Two smaller subs take more space than one large unit.

PTG angle comes in after the bare economics are settled. At this point you must pin down amount of spare capacity needed to economically handle

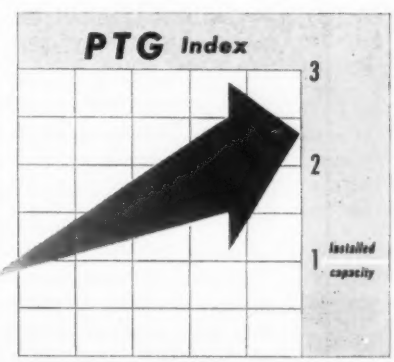
3 When first installed, typical new panelboards throughout the plant are loaded so one-third circuit capacity is left spare


15-kv cables to different bus sections in powerhouse
SECONDARY UNIT SUBSTATION
Dry-type transformers (13.8 kv to 480v 2000 kva each
Tie-breaker normally open
Substation loaded to 50% capacity on initial design
Note: Initial design load of substations varies with anticipated growth in specific area. Loadings shown are typical
Lighting panel feeds 277/480v to fluorescent lighting
Typical: 500 Mcm RH/RW
Fused panel board (no fuses over 200 amperes)
120/208v panel
480/120/208v
Circuits filled to 1/3 ultimate capacity on initial design
M
Motor starter houses two thermal overload trips

load growth in the near future. Then plan for handling double, and possibly triple, load expansions if ever needed.

With the load-center system, secondary-substation sizing is generally not too great a problem. When sizable load increases come along, additional subs are placed in the new load areas and feeders run on both primary and secondary sides. But early planning is necessary so new primary feeders can be accommodated economically.

Case in point can be found at Eastman Kodak in Rochester, N.Y. Here they follow the load-center system, leaning today toward 2000-kva double-ended unit subs. How do they provide for short-time load growth? Simply by holding substation loading to 50% capacity in typical load areas. This same reserve-capacity planning follows down the line from the secondary sub through secondary feeders and panelboards. As shown in sketch, above, the typical



Your PTG index

By tagging installed capacity as unity, the PTG index gives some measure of a system's expansibility. We define the PTG area as the planned-for-capacity that can be economically provided and integrated into an existing system. And planned PTG capacity divided by installed capacity is what we call the PTG index.

The PTG index, shown left, was selected simply to illustrate a point. You alone must decide the best PTG index for your plant.

'in secondary distribution follow a reserve-capacity plan right down the line'

new installation at Kodak Park uses 500-mcm RH/RW secondary feeders initially loaded to about two-thirds capacity. Panelboards are filled to two-thirds ultimate capacity on installaion.

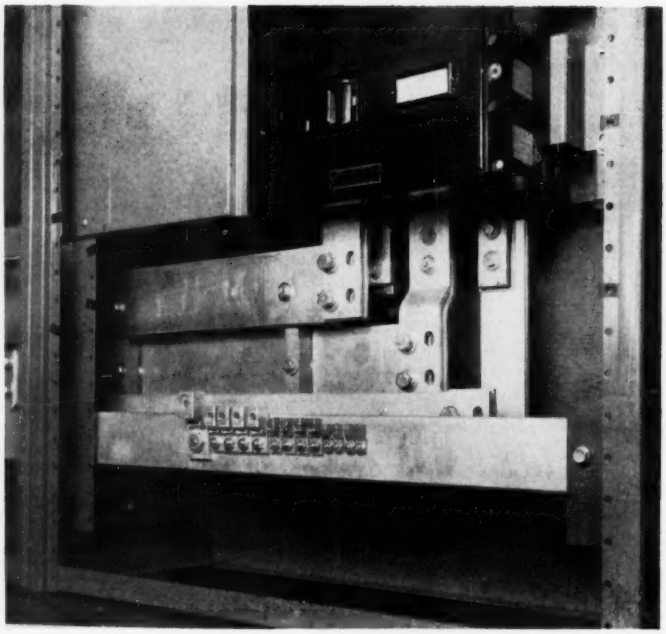
Aside from PTG thinking, there are some interesting operating considerations designed into new secondary-distribution circuits at Kodak Park. For one, all fuse ferrules, disconnects and contacts are silver plated. This precaution helps prevent circuit downtime by insuring top quality electrical connections. Also, single-link fuses are used in 1- to 30-amp circuits in the 250-v range while dual-element fuses find application above the 30-amp figure. There are no branch circuits fused above 200 amp. When specific loads call for that kind of power, a new feeder is run from the load center. This feeder generally has 400-amp capacity.

Service continuity in Kodak Park has a high-priority rating. For this reason the 480-v systems have ungrounded neutrals: exception, 277-v lighting.

Running an ungrounded system calls for systematic detection, tracing and clearing. As pointed out by Kodak's electrical-engineering consultant J A Gienger in an AIEE paper, *Experience in operating 240- and 480-volt industrial distribution systems ungrounded*, success with an ungrounded system depends on its being in a position to trace accidental ground faults with power on. (AIEE Conference paper CP 57-120, Winter General Meeting, N.Y.C., Jan 21-25, 1957).

Tracking down grounds with power on is old hat at Kodak Park. First successful ground-tracing setup here was handled with a modified automobile spark coil and a set of headphones with exploring coil attached. That rig was made and used back in 1915. Today a commercial tracer is used.

However industrial plants, in general, do not follow the ungrounded neutral practice found at Kodak Park. For most general industrial requirements a grounded neutral shows some decided advantages. Where there is some indecision regarding neutral grounding, many new plants are installing transformers with wye-connected windings and a neutral point brought out for possible later grounding. We could well look upon the practice of providing a neutral point for later grounding as an application of PTG thinking—planning ahead to meet new conditions.



Are you looking for PTG features when you specify new equipment?

Expansibility is the cornerstone of any PTG program. Providing physical space, spare ducts and conduits is but one small part of the picture. There is growing importance attached to the sizable contributions equipment manufacturers are making in building-in practical power-to-grow features during the product design stage.

These add-to equipment features often mean load growth can be handled with little loss in production time. This contrasts with the inevitable cost of downtime when installed equipment presents tough-to-expand problems.

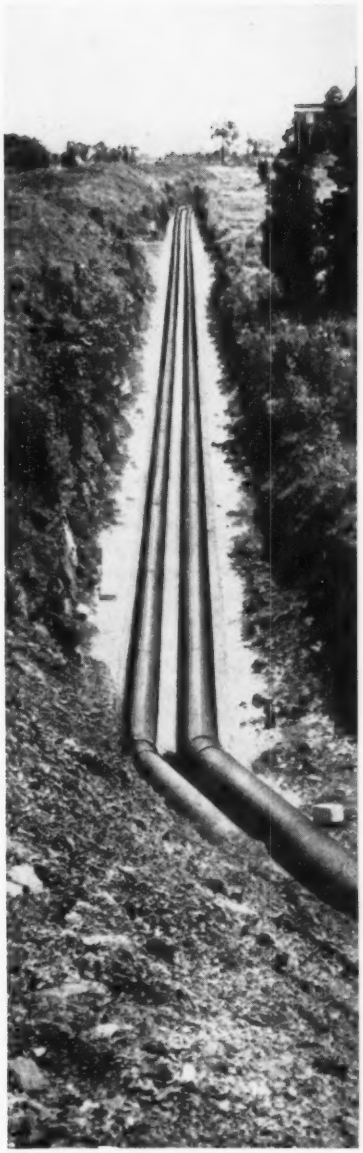
The expansibility features, in themselves, are often minor from a product-design standpoint. The bus arrangement, above, is typical. Note the provision for additional bus work should the need for it crop up. Certain equipment inherently lends itself to easy expansion. Modern motor-control centers are a case in point. Here the add-to feature comes about naturally. Likewise in the area of unit substations—as load grows, new packaged unit subs are added and additional primary feeders run in as needed.

But the simple add-on feature becomes a sizable headache if all angles are not considered beforehand. Expansibility calls for integrated planning, right from the power source to the ultimate load. Main circuit breakers, primary feeders and secondary substations must all be geared for the added load imposed during add-on. Too often easy physical expansibility means ultimate overloading and possibly exceeding the interrupting capacity rating of key switchgear. This latter problem crops up when the add-on is motor load. Here the individual induction and synchronous motors contribute to the available short-circuit current figure (POWER, Jan 1957, pp 82-85)

We figure system heating loads by applying heat-transfer basics. It's the key to understanding...

How we design a high-temperature water system

By **P L GEIRINGER**, *Chief Engineer*
and **B M VENABLE**, *Project Engineer*
The American Hydrotherm Corp



2-PIPE distribution system for h-t water heating can follow the ground's contour

► LAST MONTH (POWER, Jan, pp 75-78) we described high-temperature water heating systems and talked about their advantages. Now let's turn to the operating characteristics and design details of one installation — the Goldsboro Training School, North Carolina.

Fourteen buildings to be heated were spread over 1800 ft of rolling terrain that varied 30 ft in elevation, Fig. 1, next page. The design also had to provide for heating future buildings.

To find the most practical way of heating the school we studied pros and cons of these possibilities: (1) Build a new heating plant. (2) Utilize a nearby boiler plant that had excess capacity. (Central heating plant of the state hospital was only a mile away.) (3) Use the nearby boiler plant and feed h-t water to the school buildings.

Cost analysis showed the third proposal to be most economical from investment, operation and maintenance standpoints. And the large variation in building elevations—h-t water distribution systems follow contour of the ground—made it the most practical system to install.

How the system works. Drawing, Fig. 4, shows heat flow. Part of the steam produced by the state hospital's boilers is used in the hospital itself. Balance of production goes to the Goldsboro School. Steam heats return flow from the h-t water system, in a direct-contact cascade, to within two degrees of operating temperature. From the cascade, h-t water feeds into the distribution system via two circulating pumps. Normal operation requires only one pump; second is a standby.

Chemical feed directly into the cascade maintains water at a pH of 9.5.

Heat-transfer equipment from the boiler plant to the distribution system operates in this manner: The cascade, designed for 50,000-lb-per-hr peak steam capacity, receives water at top. Water falls from one trough-shaped tray to the next. Steam, entering near the middle, on both sides of the cascade, contacts the water by spiralling downward around the trays, thus mixing with falling water. Heated water drops into storage space at bottom of the tank; then goes to the circulating pumps. Two pumps handle 400 gpm each, at 428-F design temperature.

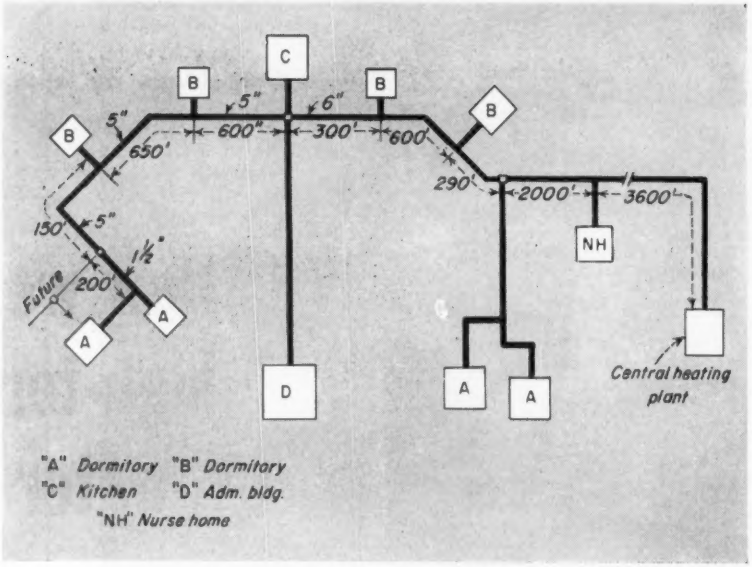
Equipment for heat consumers includes heat exchangers, hot-water generator and steam generator.

Heat exchangers convert h-t water to l-t water (200 F) for use in space heating systems. Resulting l-t water can flow to radiators, convectors, unit heaters, heating panels, heating coils or snow-melting systems.

The domestic hot-water generator supplies water at 140 F. Heating medium is the 200-F water.

The steam generator supplies 40-psig

H-t water systems can take advantage of most favorable diversity factors



1 Building layout for the Goldsboro Training School is spread out over 1800 ft. Connecting lines show how high-temperature water, distribution system fans out

steam for sterilizing. Heat source is h-t water circulating through closed coils. The steam side receives condensate feed.

Design factors. Right pressures and temperatures for h-t water heating plants depend on (1) heat requirements (2) design temperatures and capacities of heat-consuming equipment (3) distribution system length (4) available head of circulating pumps (5) installation and operating costs of the boiler house and heat-distribution equipment.

For transmission over long distances we use pressures from 175 to 300 psig —depending on cost of lines, temperatures required by consumers. Systems supplying between 50 and 100 million Btu per hour are satisfied by 250 psig. We generally recommend about 300 psig in the range of 100 to 500 million Btu. Heat losses in the system are compensated for by allowing 20 to 25 F above design flow temperature.

Boiler design. We subdivide system load into summer and winter load and into day and night load—especially when these loads are highly variable. Last month's article showed that the boiler plant for a h-t water system can be sized 15 to 20% smaller than a steam plant serving the same heating load. Our experience shows that h-t water has a more favorable *diversity factor* than steam. (*Note:* In order to figure distribution-pipe size, only a certain percentage of l-t water peak load is used as a basis for finding h-t water needs. This percentage is the diversity factor.) Range is from 50 to 85% *Reason:* Heat loads of all buildings will seldom have to be supplied at the same time. H-t water's high heat-storage capacity — especially when long runs of distribution piping are filled —favors higher diversity factors.

Number and size of boilers depends, in part, on heat requirements. For large-area heating plants (100 million Btu per hour and up) we might use 4, 6 or 8 forced-circulation boilers. To operate boilers at maximum output, a larger number of smaller boilers generally is best. Lower size limit for these is about 20 million Btu per hr, each.

Typical calculations. In figuring heat capacity, you'll have to consider the sum of the peak loads. Let's assume the building heating load is 650,000 Btu per hr and domestic hot-water load is 250,000 Btu per hr. Adding the two, we find that the converter must handle 900,000 Btu per hr.

To find h-t water flow rate through the converter, base your figuring on its full capacity. Economical design generally dictates a 10 to 15-F temperature difference between water leaving the tube bundle and water leaving the shell. Here's an example for a h-t water converter:

H-t water supply temp.....350 F
L-t water flow temp .....200 F
H-t water return temp.....215 F
H-t water temp drop.....135 F
Capacity, Btu per hr.....900,000
H-t water circulated = 900,000 ÷ 135
= 6650 lb per hr

If you take into account system heat losses, flow rate will be a shade higher.

To pinpoint distribution-pipe size: Assuming all buildings are equipped with similar h-t water converters, total converter capacty is 20 million Btu per hr. A conservative estimate pegs line heat loss due to radiation at 10%. (With double standard thickness insulation, heat loss is 4 to 6% at peak load.) Diversity factor (based on our experience) is 75% for this job. Thus, total heat load, in Btu per hr, is:

$.75 \times 1.10 \times 20{,}000{,}000 = 16{,}500{,}000$

Using an average temperature drop of 135 F (350 – 215), approximate flow through the h-t water lines is:

16,500,000 ÷ 135 = 122,000 lb per hr

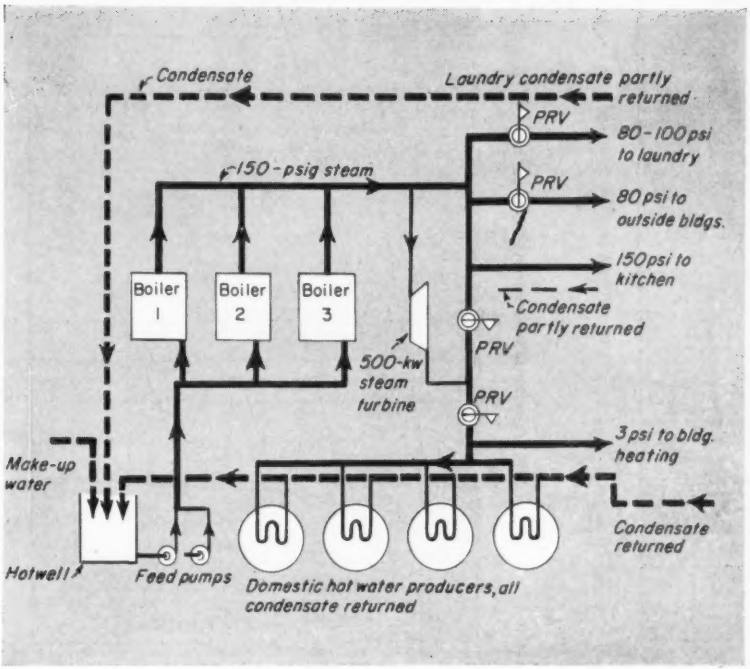
Diversity factors we generally use for h-t water systems are:

Equipment	*Diversity factor, %*
Domestic hot-water generator	50-70
H-t water converter, steam producers or space heating	75-90
Steam generator for kitchen or process equipment	50-70

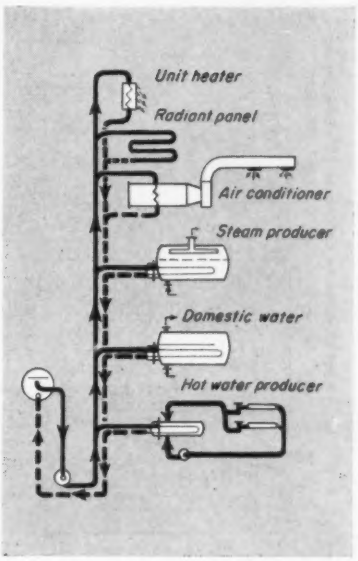
In the above example we sized the boiler plant for 16,500,000 Btu per hr.

Boiler ratings. If system generates electric power, boiler pressure may range from 400 to 2000 psig, or similar to those of conventional steam plants. Pressure must be high enough to provide needed power. Be sure that you remember to account for back-pressure of heating steam.

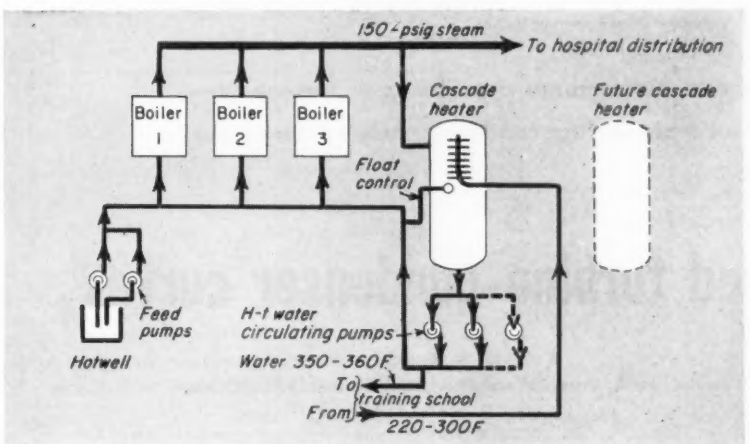
Heat sources in the hospital's boiler plant are three watertube boilers, each



2 Heat flow arrangement of hospital's boiler plant before it was modified to meet needs of the training school's h-t water system. Turbine betters heat balance



3 Top three heat consumers make direct use of high-temperature water



4 Hospital's modified boiler plant for generating, distributing h-t water to training school. Cascade heater uses 150-psig saturated steam to generate h-t water

fired with dual-unit natural-draft pulverized-coal burners. Maximum steaming rate per boiler is about 30,000 lb per hr at 150 to 160 psig. A 500-kw backpressure turbine-generator operates during winter peak loads to trim down peak demand charges on the electrical system, Fig. 2.

The training school's peak heat requirements are 18,000,000 Btu per hr, or about 18,000 lb steam per hr. Additional future load of 2,500,000 Btu per hr ups the design steam load to 20,500 lb per hr. Thus, we found the hospital's boiler plant could easily absorb the extra load and still have one boiler available for standby.

Final design figures for the Goldsboro School were pinned down at a heat transfer rate of 120 Btu per lb per hr and 170,000-lb-per-hr h-t water flow. The 360-F water operating temperature and 240-F return is handled by 6-in. schedule-40 pipe. System's available heat is actually 20,400,000 Btu per hr. This figure allows about 10% above the required peak load for transmission losses. Fig. 4 shows the heat distribution layout.

Design layout. First step is to tabulate separate loads the system must serve. When figuring loads, don't forget to consider diversity, load factors.

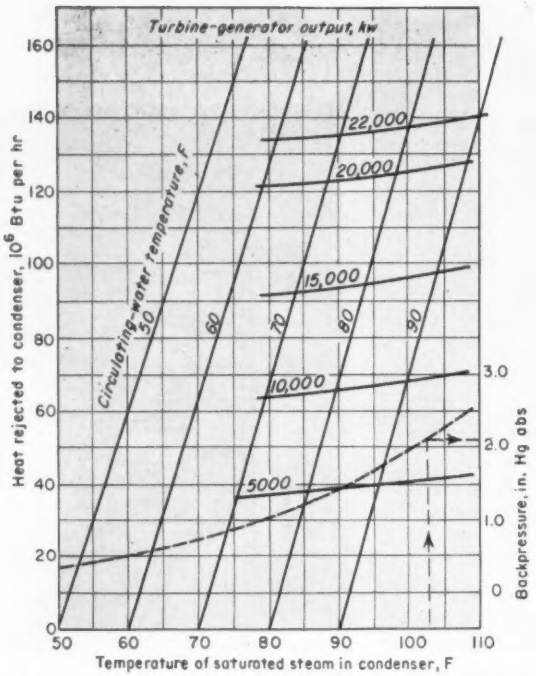
Water flow rate, W, (lb per hr) for each consumer depends on heat used, Q, (Btu per hr) and temperature drop across flow and return lines:

$$W = Q/(T_t - T_r)$$

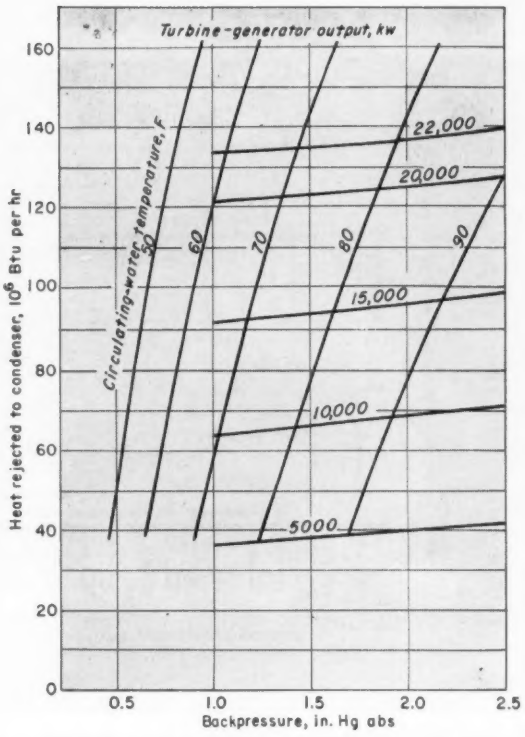
Flow temperature, T_t, depends on system's boiler pressure. Return temperature, T_r, depends on heat-consuming equipment. Dividing W by 500, we get flow rate in gpm (on a cold-water basis).

Distribution system. The most economical number and size of pipes, as well as the right number of distribution zones, depends on layout of the buildings. By grouping heat consumers according to high-return temperature, low-return temperature, constant-high-flow temperature, variable-flow temperature, continuous operation and intermittent operation, we get most flexible,

(*Continued on page* 202)



1 Plotting turbine and condenser data against exhaust-steam temperature instead of pressure makes them easy to relate



2 Conventional plotting of turbine and condenser data against backpressure makes accurate curve extrapolation difficult

If you have separate performance data for your turbine-generator and for your main surface condenser, here's how to put them together to . . .

Figure combined turbine-condenser curves

By E V POLLARD, *Medium Steam Turbine, Generator and Gear Dept, General Electric Company*

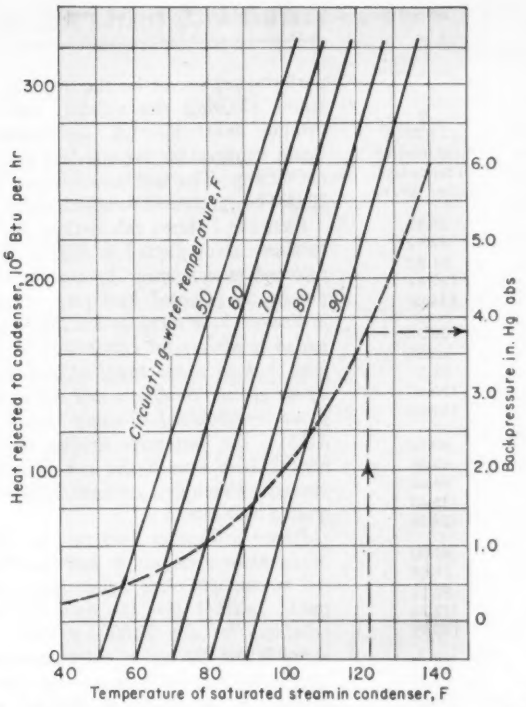
► THOUGH A TURBINE and its surface condenser must act as a single unit, the two components are designed and built by different engineering groups. As a result, the performance of the two are described independently of each other; the turbine in terms of load, heat rate and exhaust pressure and incidentally the heat rejected to condenser; the condenser in terms of heat rejected to condenser, circulating-water inlet temperature and exhaust steam pressure.

The common factors for the two components are heat rejected to condenser and backpressure or its equivalent, temperature of saturated steam. With these as links we can figure how the condenser and turbine will act as a unit. The charts and tables show you a step-by-step program which is worked out in three examples.

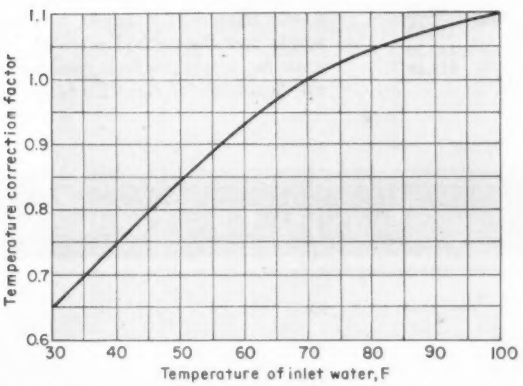
Performance data. In Example 1, columns *1*, *2* and *3* show a typical method of giving turbine-performance data. The "vertical" family of curves in Fig. 2 shows a typical method of giving condenser performance. Uneven spacing of these curves makes it difficult to interpolate. For practical use, information for both components must be transformed into a family of curves such as Fig. 6, showing combined performance of turbine and condenser.

As a first step, we find it more useful to recast the condenser data of Fig. 2 into the form on Fig. 1. This correlates the heat rejected with temperature of saturated steam in the condenser for constant circulating-water inlet temperatures. Note that the curves for constant circulating-water temperature are straight lines. At zero rejection, circulating-water temperature equals saturated steam temperature. Then all we need to know in order to plot these curves is one point for each temperature curve near the rated heat rejection. To find corresponding backpressures we use the dashed curve and right-hand scale, Fig. 1.

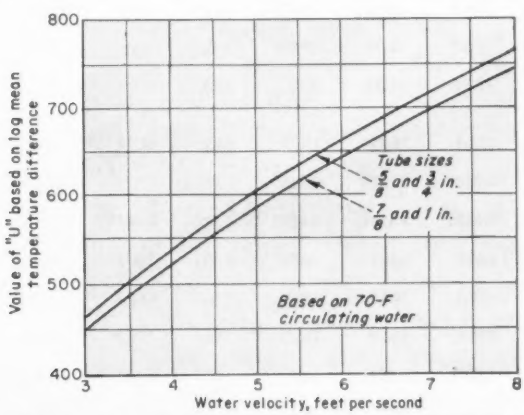
Combining data. Fig. 1 also includes



3 Condenser overload performance can be easily figured by simply extending the straight circulating water lines

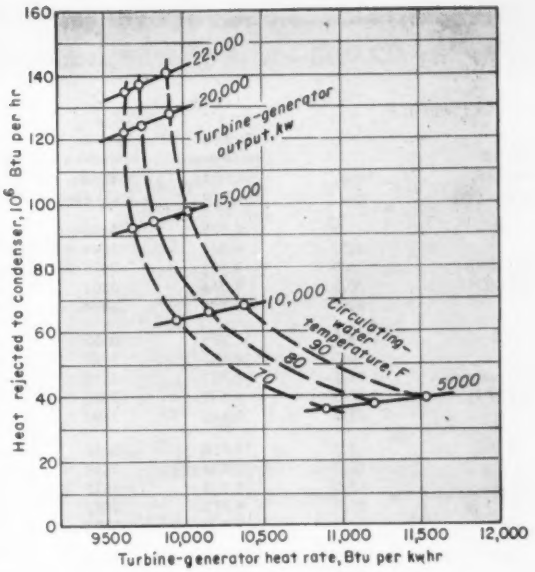


5 Cooling-water temperature correction factor from condenser standards of *Standards of Heat Exchange Institute, 1955*

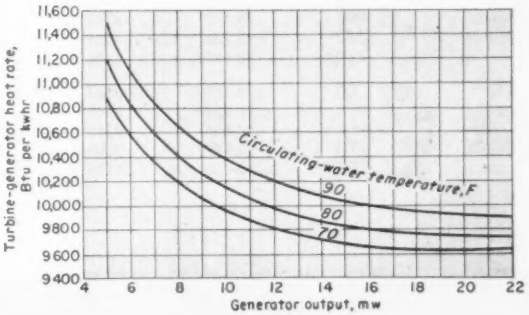

Value of "U" based on log mean temperature difference
Tube sizes 5/8 and 3/4 in.
7/8 and 1 in.
Based on 70-F circulating water
Water velocity, feet per second

7 Heat-transfer coefficient varies with cooling-water velocity through tube—*Standards of Heat Exchange Institute*

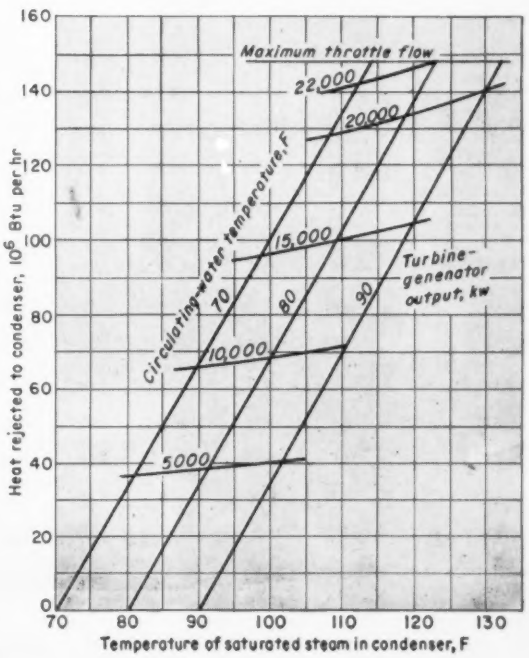
8 Performance of turbine and condenser with only half the heat-transfer surface in service can be easily calculated



4 Combining information from Example 1 and Figure 1 correlates kw load, heat rate and circulating-water temperature



6 Variation of turbine-generator heat rate with load and circulating-water temperature shows combined performance



Example 1—Calculation of heat rejected to condenser by 22,000-kw preferred standard turbine

1 Exhaust pressure, in. Hg abs	2 Load, mw	3 Turbine-generator heat rate, Btu/kwhr	4 Power utilization heat rate, Btu/kwhr	5 =3−4 Condenser heat rate, Btu/kwhr	6 =5×2/10³ Heat rejected to condenser, million Btu/hr
1.0	5.0	10,978	3663	7315	36.58
	10.0	9,941	3549	6392	63.92
(Sat. temp	15.0	9,636	3515	6121	91.82
=79.0 F)	20.0	9,574	3502	6072	121.44
	22.0	9,585	3494	6091	134.00
1.5	5.0	11,385	3663	7722	38.61
	10.0	10,185	3549	6636	66.36
(Sat. temp	15.0	9,782	3515	6267	94.01
=91.7 F)	20.0	9,657	3502	6155	123.10
	22.0	9,645	3494	6151	135.32
2.0	5.0	11,750	3663	8087	40.44
	10.0	10,433	3549	6884	68.84
(Sat. temp	15.0	9,956	3515	6441	96.62
=101.1 F)	20.0	9,772	3502	6270	125.40
	22.0	9,739	3494	6245	137.39
2.5	5.0	12,062	3663	8399	42.00
	10.0	10,654	3549	7105	71.05
(Sat. temp	15.0	10,134	3515	6619	99.29
=108.7 F)	20.0	9,916	3502	6414	128.28
	22.0	9,871	3494	6377	140.29
3.5	5.0	12,742	3663	9079	45.40
	10.0	11,146	3549	7597	75.97
(Sat. temp	15.0	10,493	3515	6978	104.67
=120.6 F)	20.0	10,205	3502	6703	134.06
	22.0	10,140	3494	6646	146.21
4.5	5.0	13,338	3663	9675	48.40
	10.0	11,554	3549	8005	80.05
(Sat. temp	15.0	10,857	3515	7342	110.13
=129.8 F)	20.0	10,520	3502	7018	140.36
	22.0	10,420	3494	6926	152.37

PERFORMANCE CURVES Continued

performance curves for the turbine-generator showing the relation between turbine heat rejection and exhaust-steam temperature for constant generator output. The turbine-generator is a 22,000-kw preferred-standard unit.

Example 1 shows calculations for the turbine curves plotted in Fig. 1. *Heat rejected to condenser* by turbine, Btu per hr = *(Quoted heat rate − power utilization heat rate) × kw load − heat added to air ejector condensate by turbine + heat added to all of feed water by air ejector condenser and boiler-feed pump − (boiler-feed-pump input ×* 3413). The last term applies only if quoted heat rate is the net heat rate for unit. Example 1, column *3*, lists the quoted heat rate.

Power utilization heat rate = 3413 × *(generator output + generator loss + mechanical loss)/(generator output)*. Table 1 lists the data and calculations for the 22,000-kw unit. To simplify our discussion, we assume that air ejector and boiler-feed-pump effects are zero in our examples. Table 1 calculations are used in Example 1 to figure heat rejected to condenser.

Normal condenser performance, Fig. 1, was figured in Example 2. This example uses the method given in *Standards for steam surface condensers of* the *Standards of Heat Exchange Insti-*

Example 2-2 — Condenser

Item	Source	Quantities										
12	Given			50					60			
13	Fig. 7 @ 12			0.842					0.928			
14	9×10×11×13			500.3					551.4			
15	Given	170,000	135,000	105,000	75,000	40,000	170,000	135,000	105,000	75,000	40,000	170,000
16	6×15/10⁵	161.5	128.25	99.75	71.25	38.0	161.5	128.25	99.75	71.25	38.0	161.5
17	16/(1×14)	17.93	14.24	11.07	7.91	4.21	16:27	12.92	10.05	7.18	3.82	15.09
18	$\frac{16\times5\times3}{1\times8\times500}$	15.76	12.51	9.73	6.95	3.71	15.76	12.51	9.73	6.95	3.71	15.76
19	12+18	65.76	62.51	59.73	56.95	53.71	75.76	72.51	69.73	66.95	63.71	85.76
20	18/17	0.8789	0.8785	0.8789	0.8786	0.8812	0.9686	0.9682	0.9681	0.9679	0.9712	1.0437
21	20/2.303	0.3816	0.3814	0.3816	0.3815	0.3826	0.4205	0.4204	0.4203	0.4202	0.4217	0.4531
22	Antilog 21	2.408	2.407	2.408	2.408	2.413	2.633	2.633	2.632	2.631	2.641	2.839
23	22×19	158.4	150.5	143.8	137.1	129.6	199.5	190.9	183.5	176.1	168.3	243.5
24	23−12	108.4	100.5	93.8	87.1	79.6	139.5	130.9	123.5	116.1	108.3	173.5
25	22−1.0	1.408	1.407	1.408	1.408	1.413	1.633	1.633	1.632	1.631	1.641	1.839
26	24/25	76.9	71.4	66.6	61.8	56.3	85.4	80.1	75.6	71.1	65.9	94.3
27	Al 26	0.935	0.775	0.657	0.553	0.457	1.23	1.04	0.895	0.77	0.64	1.625

Example 2-1—Condenser basic data

Item	Source	Quantity
1	Given	18,000 sq ft
2	Given	2 passes
3	Given	20 ft
4	Given	⅞ in. 18 Bwg Admiralty metal
5	Table 2 @ 2 & 4	0.310
6	Heat transfer	950 Btu per lb
7	Given	20,500 gpm
8	3×5×7/1	7.06 ft per sec
9	Fig. 7 @ 8 & 4	699 Btu per sq ft, hr, F, t_m
10	Table 3 @ 4	1.0
11	Given	0.85

tute, 1955. Fig. 5 and 7 and Tables 2 and 3 take data from these standards.

Example 2 includes the calculating program for condenser performance, detailed in Table 4. This involves first finding the temperature, instead of the pressure, of the saturated steam. We

(*Continued on page* 84)

Example 3—Condenser performance computations

Item	Source	Quantities				
1	Given	18,000 sq ft				
2	Given	2 passes				
3	Given	20 ft				
4	Given	⅞-in – 18 Bwg				
5	Table 2 @ 2 & 4	0.310				
6	Heat transfer	950 Btu per lb				
7	Given	20,500 gpm				
8	3×5×7/1	7.06 ft per sec				
9	Fig. 7 @ 8 & 4	699 Btu per sq ft, hr, F, t_m				
10	Table 3 @ 4	1.00				
11	Given	0.85				
12	Given	50	60	70	80	90
13	Fig. 8 @ 12	0.842	0.928	1.000	1.044	1.076
14	9×10×11×13	500.3	551.4	594.2	620.3	639.3
15	Selected	340,000	340,000	340,000	340,000	340,000
16	$6\times15/10^4$	323.0	323.0	323.0	323.0	323.0
17	16/1×14	35.87	32.54	30.20	28.92	28.07
18	16×5×3/1×10×500	31.52	31.52	31.52	31.52	31.52
19	12+18	81.52	91.52	101.52	111.52	121.52
20	18/17	0.8787	0.9687	1.0437	1.0900	1.1229
21	20/2.303	0.3815	0.4206	0.4532	0.4733	0.4876
22	Antilog 21	2.407	2.634	2.839	2.974	3.073
23	22×19	196.2	241.1	288.2	331.7	373.4
24	23—12	146.2	181.1	218.2	251.7	283.4
25	22—1.0	1.407	1.634	1.839	1.974	2.073
26	24/25	103.9	110.8	118.7	127.5	136.7
27	At 26	2.17	2.66	3.32	4.23	5.38

performance computations

70				80					90				
1.00				1.044					1.076				
594.2				620.3					639.3				
135,000	105,000	75,000	40,000	170,000	135,000	105,000	75,000	40,000	170,000	135,000	105,000	75,000	40,000
128.25	99.75	71.25	38.0	161.5	128.25	99.75	71.25	38.0	161.5	128.25	99.75	71.25	38.0
11.99	9.33	6.66	3.55	14.46	11.48	8.93	6.38	3.40	14.03	11.14	8.66	6.19	3.30
12.51	9.73	6.95	3.71	15.75	12.51	9.73	6.95	3.71	15.75	12.51	9.73	6.95	3.71
82.51	79.73	76.95	73.71	95.75	92.51	89.73	86.95	83.71	05.75	102.51	99.73	96.95	93.71
1.0433	1.0428	1.0435	1.0450	1.0892	1.0897	1.0895	1.0893	1.0912	.1225	1.1229	1.1235	1.1227	1.1242
0.4530	0.4528	0.4531	0.4537	0.4729	0.4731	0.4730	0.4729	0.4738	0.4874	0.4875	0.4878	0.4874	0.4881
2.838	2.837	2.839	2.842	2.971	2.972	2.972	2.971	2.977	3.072	3.073	3.075	3.072	3.077
234.2	226.2	218.5	209.5	284.5	274.9	266.7	258.3	249.2	324.9	315.0	306.7	297.8	288.3
164.2	156.2	148.5	139.5	204.5	194.9	186.7	178.3	169.2	234.9	225.0	216.7	208.8	198.3
1.838	1.837	1.839	1.842	1.971	1.972	1.972	1.971	1.977	2.072	2.073	2.075	2.072	2.077
89.3	85.0	80.7	75.7	103.7	98.8	94.7	90.5	85.5	113.3	108.5	104.4	100.2	95.4
1.394	1.215	1.058	0.898	2.16	1.87	1.65	1.45	1.23	2.86	2.49	2.20	1.94	1.68

Table 1—Calculation of power utilization heat rate

Generator output, kw	5000	10,000	15,000	20,000	22,000
Generator loss, kw	192	233	277	348	348
Mechanical loss, kw	175	175	175	175	175
Boiler-feed-pump input, kw	0	0	0	0	0
Turbine-wheel output, kw	5367	10,398	15,452	20,523	22,523
Power utilization heat rate, Btu per kwhr*	3663	3549	3515	3502	3494

* — Power utilization heat rate = 3413 (turbine-wheel output/generator output)

Table 4—Calculation program for condenser performance

Item	*Symbol*	*Derivation*	*Factor or formula*
1	S	Given	Condenser surface, sq ft
2	P	Given	Number of passes
3	L	Given	Tube length between tube sheets, ft
4	d	Given	Diameter, in., weight and material of tubes
5	k	Table 2 @ 2 & 4	Tube constant
6		950	Heat transfer to cooling water, Btu per lb steam
7	gpm	Given	Circulating-water flow, gpm
8	V	3×5×7/1	Velocity of water in condenser tubes, ft per sec
9		Fig. 7 @ 8 & 4	Base heat transfer rate, Btu per sq ft, hr, F, t_m
10		Table 3	Material correction factor
11		Given	Cleanliness factor
12	t_i	Given	Circulating-water inlet temperature, F
13		Fig. 8 @ 12	Circulating-water-temperature correction factor
14	U	9×10×11×13	Heat transfer rate, Btu per sq ft, hr, F, t_m
15		Selected	Steam condensed, lb per hr
16	Q	6×15	Heat rejected to condenser, Btu per hr
17	t_m	16/(1×14)	Logarithmic mean temperature difference, F
18	TR	16×5×3/(1×8×500)	Temperature rise of circulating water, F
19	t_d	12+18	Discharge temperature of circulating water, F
20		18/17	$\text{Log}_e\ [(t_x-t_i)/(t_x-t_d)]$
21		20/2.303	$\text{Log}_{10}[(t_x-t_i)/(t_x-t_d)]$
22		Antilog 21	$(t_x-t_i)/(t_x-t_d)$
23		22×19	
24		23−12	
25		22−1.0	
26	t_x	24/25	Saturation temperature of steam in condenser, F
27	P_x	At 26	Pressure in condenser, in. Hg abs

observed some years ago that, at constant circulating-water temperature, the heat rejected to condenser versus saturation temperature in condenser plotted as a straight line. This greatly simplifies interpolation.

Example 2 was worked out over a range of heat rejections to prove the proportional relation between temperature and heat rejection, as plotted in Fig. 1. Knowing this relation, all we need do in the future is calculate condenser performance at its rated capacity for each circulating-water temperature needed (as in Example 3).

Any set of condenser curves applies to a given flow or gpm of circulating water. For other flows, a new set must be figured and plotted. The turbine performance curves, however, remain the same regardless of changes in the condenser performance; heat rejection from the turbine always remains the same in relation to saturation temperature.

Condenser overload. A condenser with adequate hot-well pump and air ejector has a large overload capacity. In Example 3, we figure the performance of the condenser in Example 2 at twice the maximum heat rejection. Plotting the results on Fig. 3, we find that the curves pass through the points calculated for Fig. 1. So for part-load or overload conditions only one set of points need be calculated for the condenser.

Condenser overloads may be expected for:

1. An automatic extraction turbine with an undersized condenser which will be overloaded infrequently under emergency conditions when the higher backpressure is not important. The low-pressure section of the turbine must be able to pass the high steam flow at higher backpressure.

2. An admission turbine which usually needs an exhaust flow much higher than normal. Many of these turbines use l-p admission during warm weather when circulating-water temperature runs high, increasing the backpressure.

Performance of half condenser, when one-half of a divided waterbox is out of service, may be easily calculated. At normal maximum heat rejection, each half of the surface of a divided-waterbox condenser is assumed to condense one-half of the steam flow. Condenser performance curves for each circulating-water temperature for a half condenser can be drawn from data in Fig. 1 as follows:

1. At selected circulating-water tem-

Table 2—Condenser tube data

Tube OD, in.	Tube gage, Bwg	Tube ID, in.	Surface area, sq ft per ft length Outside	Inside	Velocity, fps for 1 gpm	Value of k for number of tube passes One	Two	Three
¾	18	0.652	0.1963	0.1706	0.9611	0.188	0.377	0.565
	16	0.620	0.1963	0.1613	1.063	0.208	0.417	0.625
⅞	18	0.77	0.2291	0.2034	0.6670	0.155	0.310	0.465
	16	0.745	0.2291	0.1951	0.7360	0.168	0.337	0.505
1	18	0.902	0.2618	0.2361	0.5022	0.131	0.263	0.394
	16	0.870	0.2618	0.2277	0.5398	0.141	0.283	0.424

Table 3—Correction factors for condenser tube material and gage

Tube material	Tube wall gage 18 Bwg	16 Bwg
Admiralty metal	1.0	0.96
Arsenical copper	1.0	0.96
Aluminum brass	0.96	0.91
Muntz metal	0.96	0.91
Aluminum bronze	0.90	0.84
90-10 copper nickel	0.90	0.84
70-30 copper nickel	0.83	0.76
Type-305 stainless steel	0.58	0.54

perature, read the saturation temperature in condenser at normal maximum heat rejection.

2. Divide this normal maximum heat rejection by two and plot this value at the same saturation temperature in condenser, Fig. 8.

3. Draw a straight line through this point and the circulating-water temperature at zero heat rejection, and extend to maximum normal heat rejection, Fig. 8. This is condenser performance for one-half the condenser surface.

The turbine curves from Fig. 1 can then be plotted on Fig. 8. At turbine heat rejection 1% greater than value for 22,000-kw load at 3.5 in. Hg abs backpressure draw a horizontal line. This represents the maximum guaranteed throttle flow. From these combined curves we can figure the maximum capability of the turbine with one-half the condenser in service.

Turbine exhaust size can only be economically evaluated when we know how the turbine will perform with the condenser. Fig. 1 shows that as the turbine load decreases the backpressure also decreases. This means the turbine's leaving loss decreases at a slower rate than when operating at constant backpressure.

For a constant circulating-water temperature, the leaving losses at low and high kw loads will be of comparable amounts. With a less expensive higher-leaving-loss exhaust on the turbine, the leaving loss will be higher also at the lower loads.

As the circulating-water temperature increases, however, the leaving loss will decrease. So we can't evaluate a turbine exhaust size without knowing how it affects performance of both turbine and condenser.

Combined performance. Fig. 6 shows

(*Continued on page 202*)

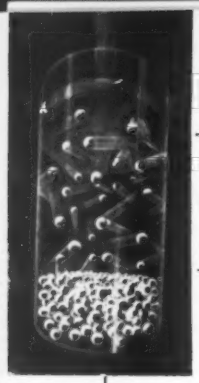
Table 5—Condenser formulas used in calculation program

Item	Formula
5	$k = \frac{0.107 \times d}{(d - 2t)^2} \times P$
8	$V = \frac{L \times k \times gpm}{S} = \frac{gpm \times 8.33 \times \pi \times d \times L \times P \times 144}{62.4 \times 60 \times S \times 12 \times \pi \times (d - 2t)^2}$
17	$t_m = \frac{Q}{S \times U} = \frac{(t_d - t_i)}{\log_e \frac{(t_x - t_i)}{(t_x - t_d)}}$
18	$TR = \frac{Q \times k \times L}{S \times V \times 500} = t_d - t_i$
19	$t_d = t_i + TR$
20	$\log_e \frac{(t_x - t_i)}{(t_x - t_d)} = \frac{TR}{t_m}$
21	$\log_{10} N = (\log_e N)/2.303 = \log_e \frac{(t_x - t_i)}{(t_x - t_d)} \div 2.303$
22	$\frac{(t_x - t_i)}{(t_x - t_d)}$
23	$\frac{(t_x - t_i)}{(t_x - t_d)} \times t_d$
24	$\frac{(t_x - t_i)}{(t_x - t_d)} \times t_d - t_i = \frac{t_x \times TR}{(t_x - t_d)}$
25	$\frac{(t_x - t_i)}{(t_x - t_d)} - 1 = \frac{TR}{(t_x - t_d)}$
26	$\frac{t_x \times TR}{(t_x - t_d)} \times \frac{(t_x - t_d)}{TR} = t_x$

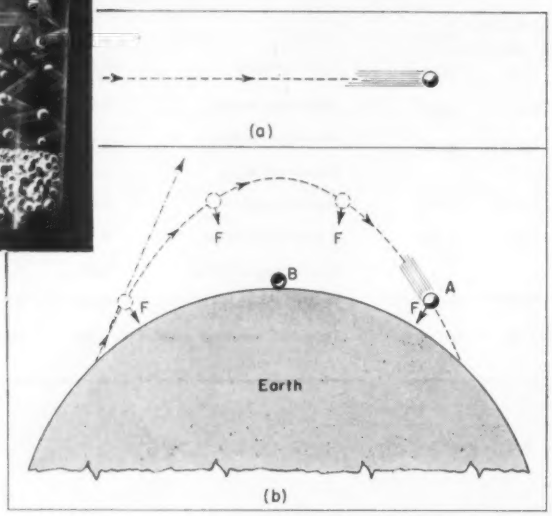
Where: t = tube-wall thickness, in.

N = any number

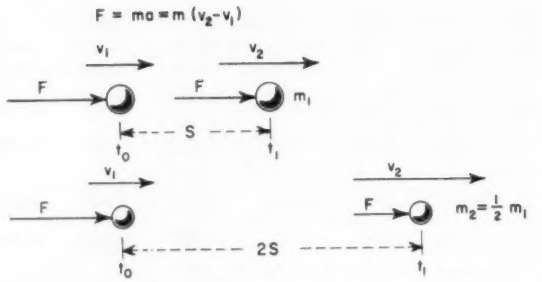
For other symbols see Table 4



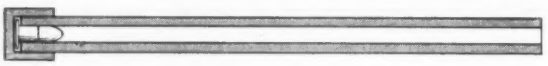
THERMO REFRESHER NO. 6



1 (a) Moving body unaffected by unbalanced force moves in straight line at constant speed. (b) Gravitational pull of earth prevents straight line motion of *A* by action of *F*



2 Newton's second law of motion relates effect of force *F* on change of velocity of a body having a known mass *m*



(a) No motion - no forces

(b) Equal forces act on bullet and gun breech

3 Newton's third law of motion shows: a force causing action on one body has an equal reactive force on other body

Energy changes in a gas can be understood more easily if we know how the molecules probably behave. This month we learn how momentum and kinetic energy ideas combine to . . .

By B G A SKROTZKI
Associate Editor

Build up kinetic molecular theory

► OVER THE PAST 100 YEARS scientists have built up the kinetic molecular theory to explain the behavior of gases. This theory assumes that atoms and molecules of a gas act as hard, perfectly elastic spheres or balls. While we now know that an atom consists of neutrons, protons and electrons inside an enormous amount of empty space, this knowledge plays no part in the kinetic theory.

From experimental work and the kinetic theory we can roughly calculate the following data about oxygen:

Diameter of O_2 molecule ..... 1×10^{-8} in.
Mass of an O_2 molecule ..... 1.2×10^{-27} lb.
Average molecular velocity at 32 F, 14.7 psia
950 miles per hr
Number of molecules at 32 F. 14. 7 psia
7.62×10^{23} per cu ft
Number of collisions per molecule at 32 F, 14.7 psia
4.2×10^{9} per sec

These numbers are all very large or very small—in either case hard to visualize directly, since we don't "experience" them in every day events. As indicated by the speed of the molecules and their enormous number we can see that there is a vast amount of activity and energy in oxygen even at the "freezing" temperature of 32 F.

Slamming of these molecules into the wall of the tank holding the gas produces what we call pressure. To insure understanding the implications of the kinetic theory let us review the basic ideas of force, motion, energy and work.

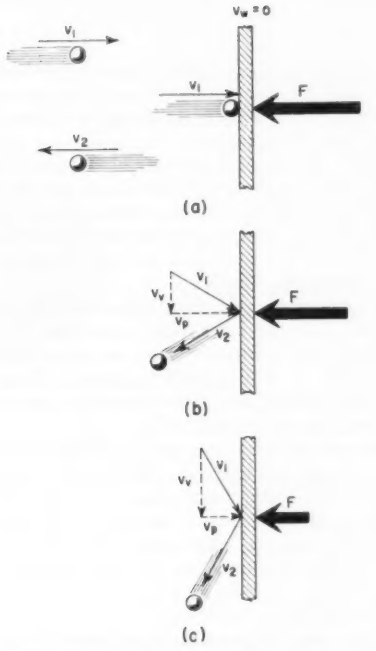
Newton's laws of motion form the basis of the kinetic theory. Here they are:

1. A stationary body stays at rest and a moving body keeps moving in a straight line at constant speed as long as no unbalanced force acts on them.

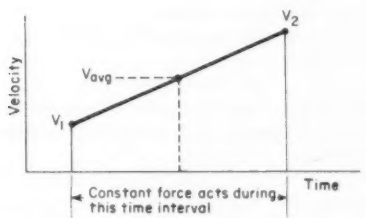
2. A force acting on a body equals the mass of the body multiplied by the acceleration of the body in the direction of motion of the force.

3. For every action of a body there is an equal and opposite reaction on another body.

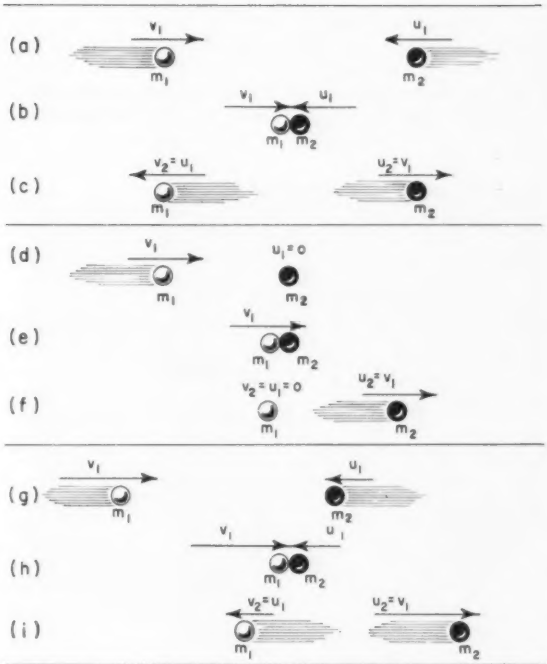
First law. We have no trouble with the body at rest. We know it can't move unless a force is applied to it by some other body. The body *B* in Fig. 1*b* is at rest, relative to the



4 Molecule colliding with wall exerts force balanced by reactive force of wall. Only v_p component produces force



5 Constant force acting on a body produces an acceleration that gives a uniform change of velocity during the period



6 When free molecules of equal masses moving on common straight path collide they simply exchange their speeds

earth, and will stay so unless something comes along to move it.

When we throw a stone into the air it always falls back to earth again in an arc, like *A* in Fig. 1*b*. It doesn't travel in a straight line. If we could take this stone into outer space, far from the earth, planets and stars, and throw it, it would move in a straight line as in Fig. 1*a*, because no unbalanced force would act on it. On earth we can't get away from the unbalanced force *F* exerted by gravitational pull of the earth. If an object is thrown with enough initial speed it can escape from the earth—after *F* diminishes to zero, or effectively so.

The idea of a moving body keeping going after it has been started is contrary to our experience. To accept this notion we have to recognize that frictional effects exert unbalanced forces on moving bodies that brings them to a halt.

In the world of molecules there are no frictional effects. Between collisions the molecules travel freely in comparatively wide-open space. The kinetic theory assumes that on the whole the molecules are so far apart that the forces of attraction between them (POWER, Aug. 1956, p. 101) become so small they can be ignored. The molecules travel so fast that gravitational pull of the earth does not deflect them appreciably between collisions. This lets the molecules completely fill the tank holding the gas.

Second law. This law simply tells us how we can measure a force:

$$F = ma = m\,\frac{(v_2 - v_1)}{t} \qquad (1)$$

where

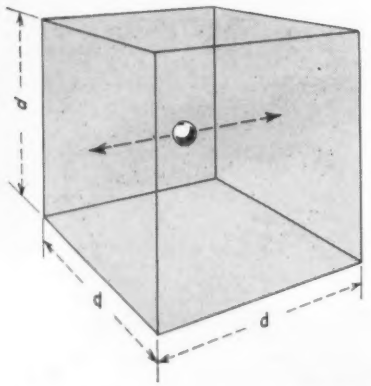
F = force, pounds a = acceleration, feet per sec per sec
m = mass, slugs v = velocity, ft per sec
t = time, seconds

We usually measure both force and mass in pounds—to use these units we must rewrite equation (1) as:

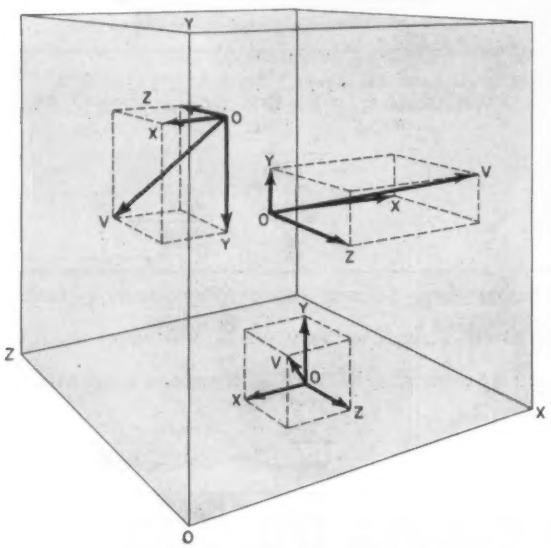
$$F = \frac{W}{g}\,a = \frac{W}{g}\,\frac{(v_2 - v_1)}{t} \qquad (2)$$

where

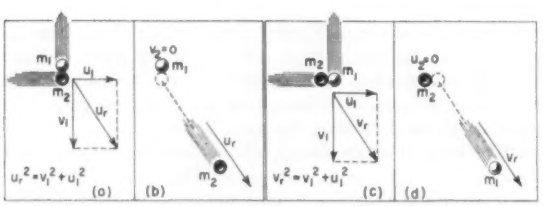
W = weight of mass, lb
g = gravitational acceleration = 32.2 ft per sec per sec



7 Kinetic theory build-up starts with one molecule bouncing between opposite parallel walls in a cubical container



8 Any velocity of a molecule can be resolved into three components that are perpendicular to wall of cubical tank



9 When one molecule hits another at right angles, first one stops, sends second one off at angle with more energy

Equations (1) and (2) show that 1 lb mass equals 32.2 slugs. We'll generally use the simpler form of (1) in our discussion because the W/g term is simply a conversion factor for reconciling measuring systems.

Fig. 2 shows the physical meaning of the second law. The acceleration (rate of change in velocity v) acts in the direction of the force F. When the same force acts on a mass half as large $m_2 = \frac{1}{2}m_1$ the distance covered s in the time of action of the force $t_1 - t_0$ doubles and the change in velocity $v_2 - v_1$ or acceleration doubles.

In dealing with forces, velocities and accelerations, we must keep in mind that they are vector quantities. This means that in adding and subtracting them we must take account of their direction as well as their magnitude. When they all act along one straight line these quantities can be simply added and subtracted arithmetically.

Third law. A force cannot exist by itself, it has to be exerted by a body or substance. When such a body exerts a force on another body, it experiences a balancing reactive force in the opposite direction exerted by the body being acted upon. For instance, when you throw a ball, your hand exerts an accelerating force on the ball giving it motion. In turn the ball exerts a reactive force on the hand equal to the force developed by the hand.

Fig. 3 shows what happens in a gun barrel firing a bullet. When the powder explodes it exerts an accelerating force on the bullet and at the same time an equal reactive force on the breech making the gun recoil. If the gun was not fastened to a mount and free to travel it would move in the direction opposite to the bullet, but at a slower speed because of its much greater mass.

To see how these motions are related let's rewrite equation (1) in the form:

$$Ft = mv_2 - mv_1 \qquad (3)$$

Here Ft is the *impulse* and mv is the *momentum*. This equation says that the change of momentum of a body equals the impulse acting on it.

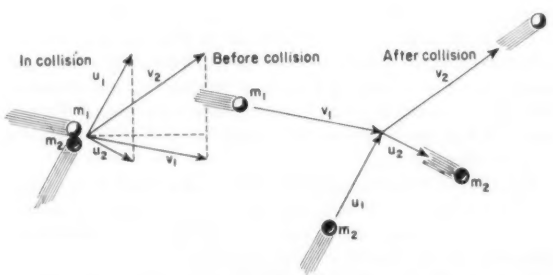
In Fig. 3 if the force F (active and reactive) stays constant during the time of action, then letting active force on the bullet be F_1 and the reactive force on the gun barrel and breech be F_2 the third law says that $F_1 = -F_2$.

Impulse on the bullet is: $F_1 t = m_1 (v_1 - O)$

Impulse on the gun is: $F_2 t = m_2 (u_2 - O)$

Then: $F_1 = -F_2 = m_1 v_1 / t = -m_2 u_2 / t$

Clearing: $m_1 v_1 + m_2 u_2 = O \qquad (4)$



10 In general collision between molecules, they exchange velocity components in parallel with line connecting their centers but keep components at right angles to line

This says that the sum of the momenta of two interacting bodies always equals zero.

Conservation of momentum. Knowing the masses of two interacting bodies m_1 and m_2 we can easily figure what their relative velocities could be by equation (4). This however, applies only to masses starting from zero velocity. We can develop a more general equation by the same method used for (4) which expresses the law of conservation of momentum.

This is analogous to the first law of thermodynamics concerning energy (POWER, Jan 1957, p 96). Let's derive the momentum law:

For mass m_1: $F_1 t = m_1 v_2 - m_1 v_1$

For mass m_2: $F_2 t = m_2 u_2 - m_2 u_1$

Third law says:

$$F_1 = -F_2$$

Substituting, combining, and cancelling t's:

$$m_1 v_2 - m_1 v_1 = m_2 u_1 - m_2 u_2$$

Rearranging $$m_1 v_1 + m_2 u_1 = m_1 v_2 + m_2 u_2 \qquad (5)$$

This is the law of conservation of momentum—in words—the sum of the momenta of two interacting bodies before collision equals the sum of the momenta after collision.

In equation (5) we usually know m_1, m_2, v_1 and u_1, but we have two unknowns, v_2 and u_2. Using this in analyzing the kinetic theory of molecules we would know velocities before impact but only an infinite number of possible pairs of values of velocities after impact. To find exact values we have to use our first law of thermodynamics.

Molecular kinetic energy. To know what happens after impact we must remember that the spheres will have the same total kinetic energy after collision that they had before collision. Let's evaluate kinetic energy of a molecule by using Galileo's equations of motion.

When a force acts on a body it produces uniformly accelerated motion changing velocity from v_1 *to* v_2, Fig. 5. The average velocity during the accelerating period is:

$$v_a = \frac{v_1 + v_2}{2} \qquad (6)$$

Acceleration is: $a = (v_2 - v_1)/t$

Rearranging $at = v_2 - v_1$

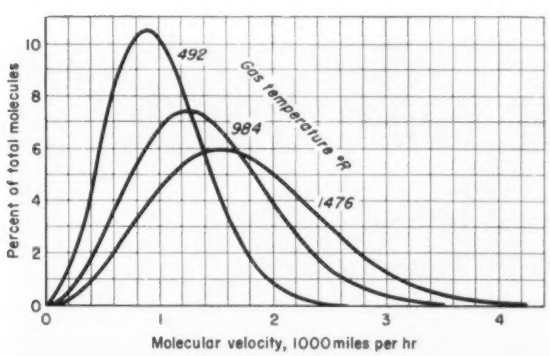
$v_2 = v_1 + at$

Substituting in (6)

$$v_a = \frac{v_1 + (v_1 + at)}{2} = v_1 + \tfrac{1}{2}at = \frac{s}{t}$$

where s is the distance traveled during time t, then:

$$s = v_1 t + \tfrac{1}{2}at^2 \qquad (7)$$



11 Molecular velocity distribution ranges over larger spread of speeds as gas temperature rises. Speed for greatest percentage of molecules at each temperature is most probable

If the body is started from rest this equation becomes:

$$s = \tfrac{1}{2}at^2 \qquad (8)$$

From an energy standpoint, work done on a molecule in starting it from rest equals the kinetic energy KE acquired by the molecule, or:

$$KE = F \times s$$

substituting $$KE = ma \times \tfrac{1}{2}at^2 = \tfrac{1}{2}ma^2t^2$$

but final velocity when starting from rest $v = at$, then:

$$KE = \tfrac{1}{2}mv^2 = Wv^2/2g \qquad (9)$$

Equation (5) gives us the momentum conservation law, the companion energy conservation equation gives us:

$$\tfrac{1}{2}m_1v_1^2 + \tfrac{1}{2}m_2u_1^2 = \tfrac{1}{2}m_1v_2^2 + \tfrac{1}{2}m_2u_2^2 \qquad (10)$$

The sum of the kinetic energies of two bodies or molecules before collision equals the sum of the kinetic energies after collision.

Rearranging (10):

$$m_1(v_1^2 - v_2^2) = m_2(u_2^2 - u_1^2)$$

Factoring we get:

$$m_1(v_1 + v_2)(v_1 - v_2) = m_2(u_2 + u_1)(u_2 - u_1)$$

From (5) we have:

$$m_1(v_2 - v_1) = m_2(u_1 - u_2) \qquad (10a)$$

Dividing the last equation into the preceding one we get:

$$(v_1 + v_2) = (u_1 + u_2) \text{ or } v_1 - u_1 = u_2 - v_2 \qquad (11)$$

The last relation means that the relative speed of approach between two bodies before collision equals the relative speed of recession after collision. Note that this is independent of the masses of the bodies involved.

Now we're ready to find the solution for v_2 and u_2. Next let's rearrange (11): $v_2 = u_1 + u_2 - v_1$

Substitute this in (10a): $m_1(u_1 + u_2 - 2v_1) = m_2(u_1 - u_2)$

$$m_1u_1 + m_1u_2 - 2m_1v_1 = m_2u_1 - m_2u_2$$

$$u_1(m_1 - m_2) + u_2(m_1 + m_2) = 2m_1v_1$$

When $m_1 = m_2$, the case for collisions between like molecules:

$$2m_2u_2 = 2m_1v_1 \quad \text{or} \quad u_2 = v_1 \qquad (12)$$

This means that velocity of one molecule after collision equals the velocity of the other before collision. If we substituted $v_1 = u_1 + u_2 - v_2$ from (11) in (10a) we would find that $v_2 = u_1$. In other words, like masses or molecules simply exchange velocities during collisions. This simply demonstrates the conservation of momentum, showing that momentum existing in a given direction still persists after collisions between bodies.

Figure 6 shows how molecules exchange velocities when they move along the same straight line. This assumes that $m_1 = m_2$. When the masses differ we have the more complicated equation:

$$u_2 = \frac{2m_1v_1 - u_1(m_1 - m_2)}{m_1 + m_2}$$

When m_1 and m_2 move along different lines before collision the exchange must be figured by vectors.

Molecular collision with walls. In this type of impact the wall doesn't move but simply sets up a reactive force F when hit by the molecule, Fig. 4. We can explain this action by saying the wall exerts an impulse on the molecule to change its momentum:

$$F_1t_1 = mv_2 - mv_1$$

But equation (11) tells us that the sum of the velocities of two colliding bodies must be equal before and after impact; then since wall velocity is zero:

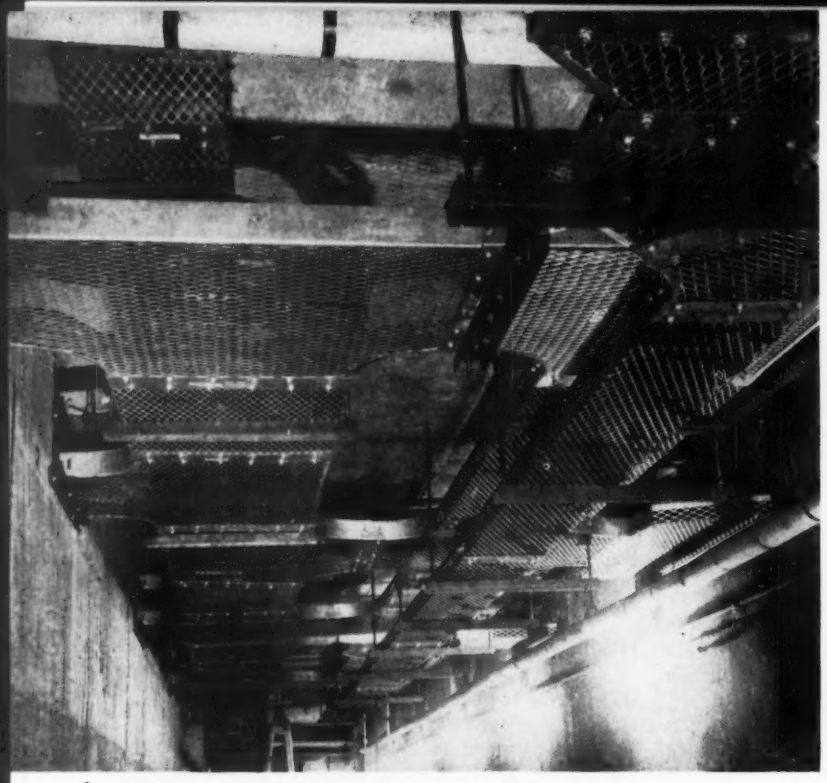
$$v_1 + v_2 = 0 \quad \text{or} \quad v_1 = -v_2$$

in words, molecular speeds before and after collision with wall are equal but opposite in direction. Substituting in previous equation we get:

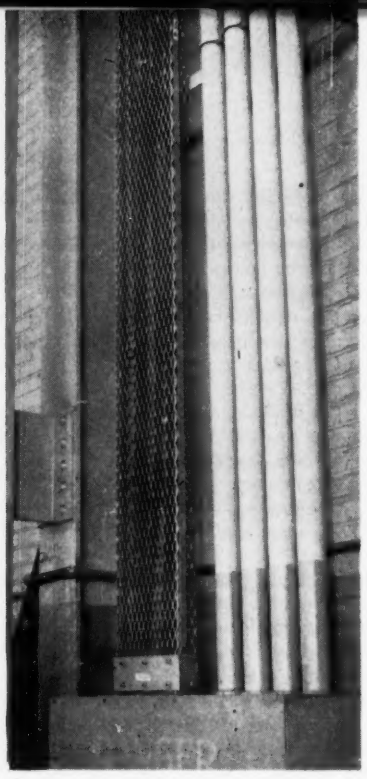
$$F_1t_1 = m[v_2 - (-v_2)] = 2mv_2 = 2mv_1$$

or $$F_1 = 2mv_1/t_1$$

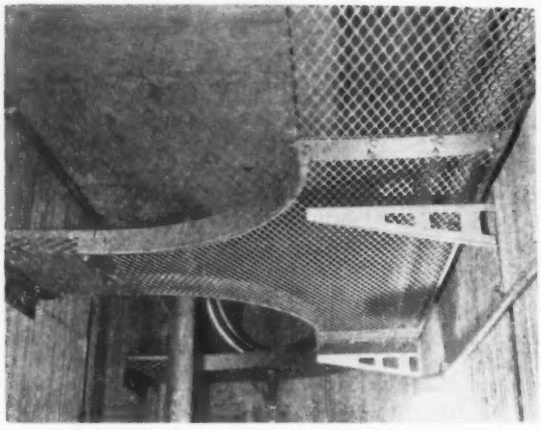
A single molecule exerts a (*Continued on page* 206)



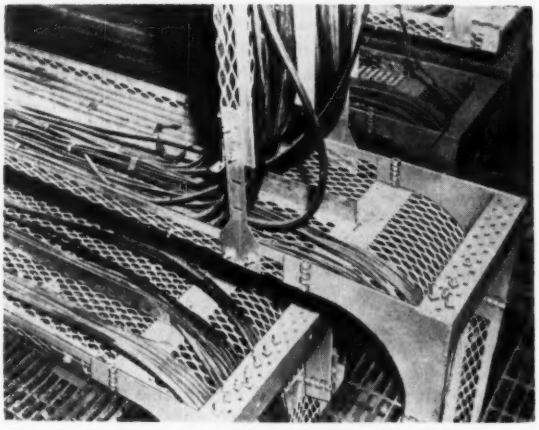
1 Across a ceiling in an underfloor cable room...



2 Or stubbed from a box



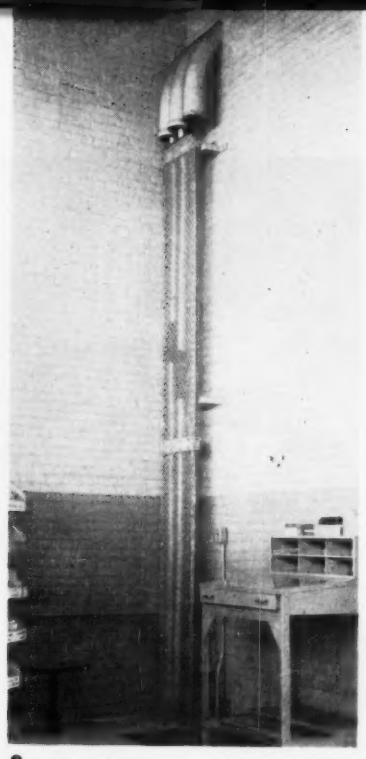
6 A double feed to a single run...



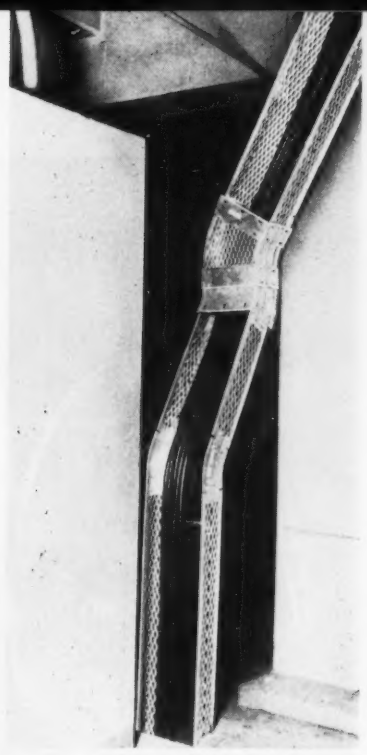
7 Dropped through a 90-deg fitting

10 design tips for cable trough

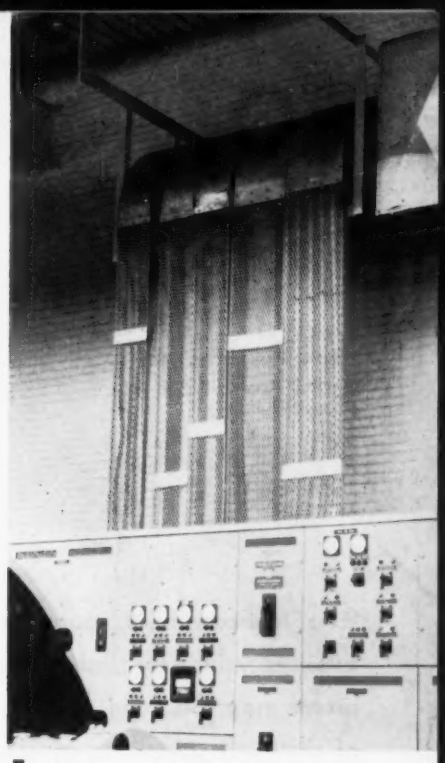
With flexibility and expansibility uppermost in today's electrical designers' minds, the practical aspects of economically laying out a cable-trough system are becoming increasingly important. Here are 10 on-the-job wrinkles to help you on your next trough layout



3 **Combined with conduit**

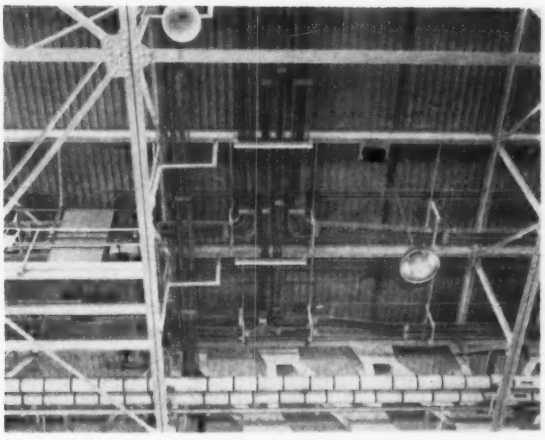


4 **Shifted to new plane...**

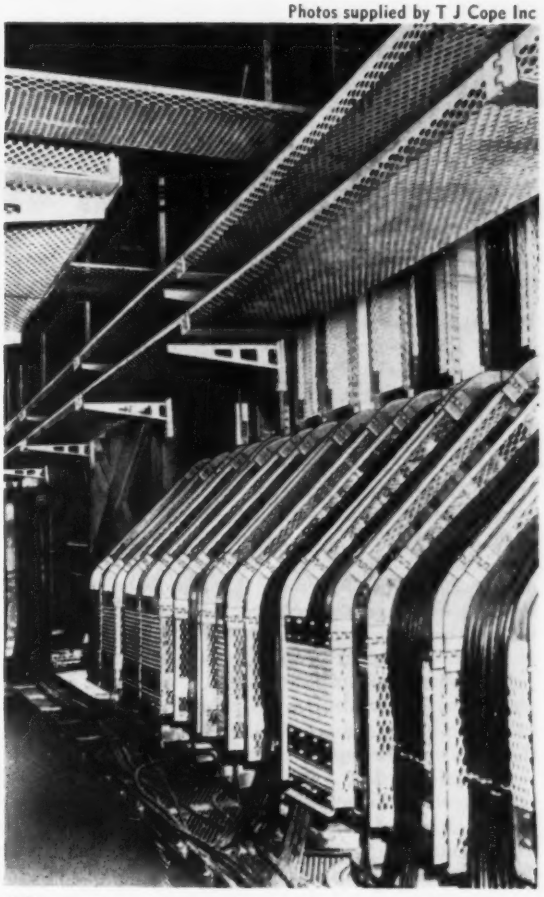


5 **Yet easily tied to gear**

Photos supplied by T J Cope Inc



8 **Trough suited for substation feeds**

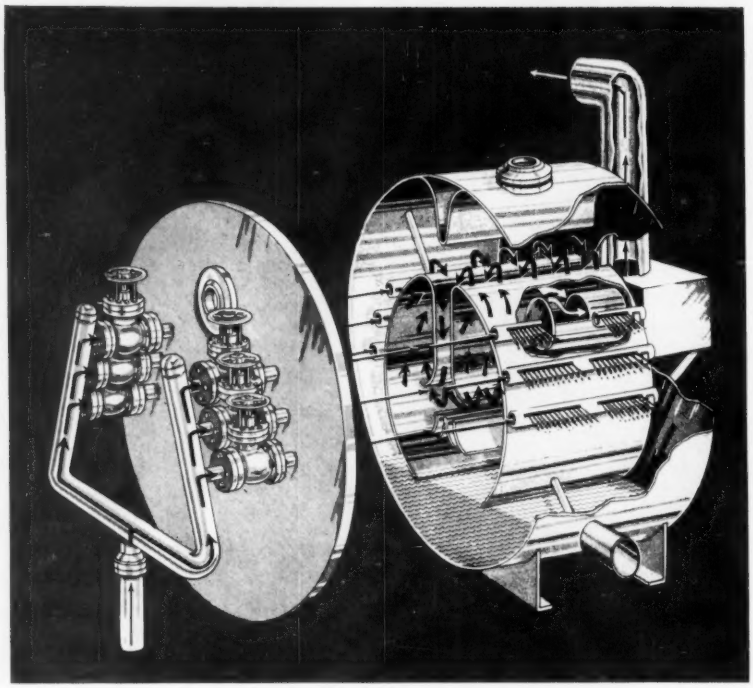


10 **Or built up from a trough base**

9 **Off the sidewall onto a ceiling...**

By R L COIT
Westinghouse Electric Corp
and Y S TOULOUKIAN
Purdue University

If a low-cost heat source is available, this new flash evaporator may solve the problem of distilling quantities of sea water cheaply. Here's background information plus up-to-date test results:



1 Experimental flash evaporator has 84 in. ID, 3 ft length. Arrows show sea water and vapor paths. Note flow reversals to remove entrained water droplets

Experimental flash evaporator yields

► ECONOMIC DEVELOPMENT of regions where fresh water is short depends largely on a cheap way to produce water for drinking and for power production and process use. In many areas this means converting polluted or sea waters to potable water.

Most sea water contains about 35,000 ppm of total dissolved solids. Potable water should have from 500 to 1000 ppm, although in some locations people drink water with 4000 ppm. So dissolved solids in sea water should be reduced by a factor of 70 to make it acceptable for drinking.

Previous attempts. Distillation is one well-known way to do the job. There have been major advances in the field. Here are three examples:

(1) Triple-effect submerged-tube evaporators are operating in Kuwait, on the Persian Gulf. These produce large quantities of potable water.

(2) Small stills operating on solar energy were developed during the last war. These were for emergency use on life rafts and in remote locations. Experiments on larger installations are now in progress.

(3) Flash evaporation of relatively warm ocean-surface waters has been tried as far back as 1929. Plan was to use colder waters from greater depths to condense the distilled vapor after it expanded through a turbine. The turbine was supposed to generate enough electrical power to drive necessary pumping equipment. First attempts were unsuccessful. But recent studies indicate such a cycle is nearly practicable. There are favorable oceanographic thermal gradients in some deep coastal areas.

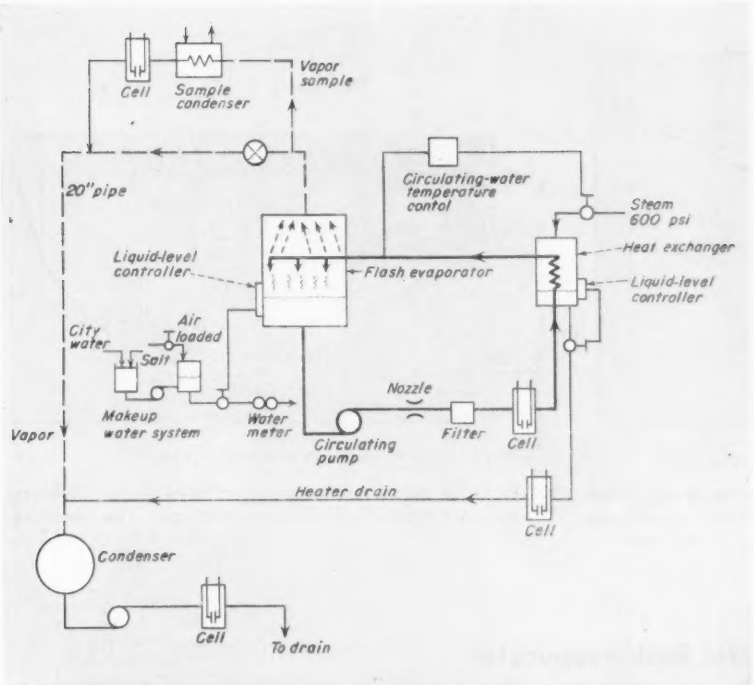
Main goal in these efforts is to produce fresh water from sea water at low or zero cost.

Advantages. Flash evaporation is an ideal method, regardless of the energy source used. While the principle is not new, large scale application is. Here are the main advantages:

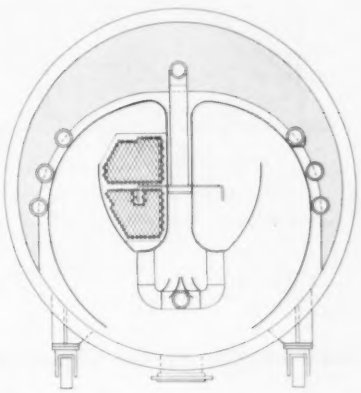
(1) You can use low-temperature waste heat sources. (2) High efficiency is possible; evaporation takes place on the water droplets rather than on tubular heat-transfer surfaces that may corrode and scale. (3) Multiple-effect arrangements can be used with low-temperature differences. (4) Equipment weighs less and takes less space than conventional shell and tube evaporators. (5) Initial cost is lower; maintenance time and cost are cut to a bare minimum.

Flash evaporation theory. Steam tables and tables of thermodynamic properties of salt-water solutions show the thermodynamic equilibrium states of water before and after flashing. This lets you calculate maximum evaporation in flashing saturated water from a higher to a lower pressure. The tables are based on thermodynamic equilibrium between the vapor and liquid phases. But in actual processes equilibrium conditions are not present. Promoting turbulence and increasing effective surface area helps produce maximum evaporation.

For a long time men thought fine atomization was best as it presents a



2 Experimental test circuit. Sea water circulates through heat exchanger and into evaporator. Controls maintain constant liquid levels and temperature for test



3 Integral twin-bundle condenser could be incorporated in the evaporator

16.6 gpm at 154-F inlet temperature

large surface for evaporation. This is true, but increasingly finer atomization rapidly approaches the point of diminishing returns, and there is an accompanying adverse effect on carryover.

The mechanism of flashing saturated or metastable water is similar to exploding a sheet of water. Volume of dissolved gases and preformed vapor nuclei within the water increases rapidly because of the pressure drop at the instant of flashing. Corresponding saturation temperature decreases. Considering mass transfer at liquid-vapor interfaces and heat conduction within the mass of a liquid droplet, we theorize that most of vapor is released when liquid mass disintegrates.

If this is true, fine atomization would quickly reach a state of diminishing returns because temperature differential between minute liquid particles and surrounding vapor is small.

In other words, we propose that droplet formation and vapor release occur simultaneously. Fine droplets are relatively low in average temperature. Thus they contribute only a small fraction of the total vapor released by surface evaporation.

We suggest this definition for "thermodynamic effectiveness" of flash evaporation:

$$(1) \quad e_f = (T_1 - T_o) \,/\, (T_1 - T_s)$$

Here, e_f = flashing effectiveness; T_1 = water temperature before flashing; T_o = temperature of unflashed water leaving the evaporator shell; T_s = saturation temperature of water corresponding to evaporator shell pressure.

This definition does not rate performance of the flash evaporator as a whole. It does not indicate carryover characteristics or thermal efficiency of the whole system.

Design considerations. Here are two important design considerations:

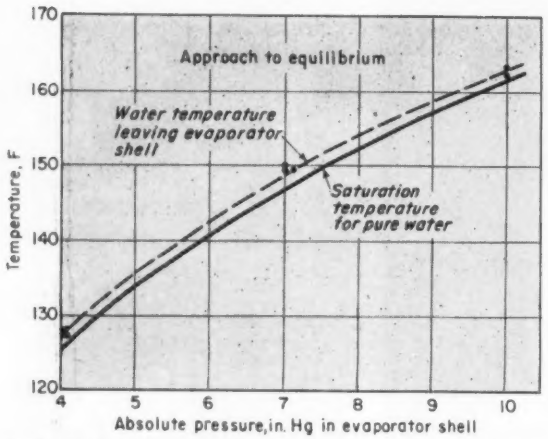
(1) Feed temperature should be as low as possible to permit use of low-grade energy sources and minimize high-temperature corrosion problems.

(2) Temperature difference available for flashing should be as high as possible. The percent of vapor flashed is proportional to the temperature drop (being almost 1% for each 10 F drop between 100 and 200 F). High fractions of vapor released per pound of water circulated would reduce pumping power requirements for a given vapor generation capacity.

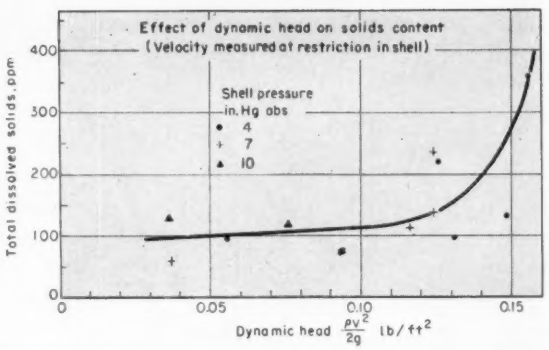
You immediately spot conflicting interests. The lower the feed temperature and greater the temperature drop, the greater the specific volume of the vapor becomes. (This is nearly inversely proportional to the pressure level in the evaporator.) So large piping and large evaporator volumes are required to keep vapor velocities reasonable and avoid high-friction losses and excessive carryover.

Experimental evaporator. Fig. 1 shows the Westinghouse test evaporator. This unit was designed to obtain performance data applicable to full-sized commercial units.

The cylindrical shell is 84 in. ID, 3 ft long. For more capacity, shell length could be increased. The experimental unit has observation windows that


Approach to equilibrium
Water temperature leaving evaporator shell
Saturation temperature for pure water
Temperature, F
Absolute pressure, in. Hg in evaporator shell

4 Unflashed water is about 1.5 F above pure-water equilibrium temperature, but within .5 F of salt-water equilibrium



5 Effect of dynamic head on vapor solids content indicates the effectiveness of the accelerating nozzle separator

Shell length of the experimental flash evaporator could be increased for more fresh-water output

would probably not be incorporated in a production model.

Heated sea water enters the six 3-in. spray pipes and discharges through slots to the shell. Since shell pressure is low, some water flashes into vapor. Most of the remaining liquid falls to the bottom of the evaporator, but the smaller droplets are entrained by the vapor. This flows up, then down through the vertical central passage constituting a two-dimensional accelerating nozzle. Here wet vapor accelerates and subsequently reverses its direction.

Momentum makes the denser water droplets impinge on the water surface below, while the relatively dry vapor reverses its direction and is led away. This separates all but the smallest entrained droplets. Vapor is then condensed in an external condenser.

Experimental setup. Fig. 2 shows the facilities for testing the experimental evaporator. The sea water circulates through a heat exchanger that raises temperature to the desired value. Water then flows through the spray pipe slots and into the lower-pressure region in the shell. Some water vaporizes; the rest is recirculated.

Liquid-level control in the evaporator actuates the makeup water system and maintains a constant level. An open storage tank, air-loaded constant-pressure tank, centrifugal pump, pneumatically-operated control valve and integrating water meter comprise the makeup system.

A sampling system extracts some wet vapor, condenses it and passes it through a degassing cell to measure condensate purity.

Solids content of the circulating sea water is measured by an immersion-type conductivity cell. A separate cell measures condensate purity leaving the condenser hotwell. Since this condensate includes steam condensed in the heat exchanger, solids content in the heater drain must be measured.

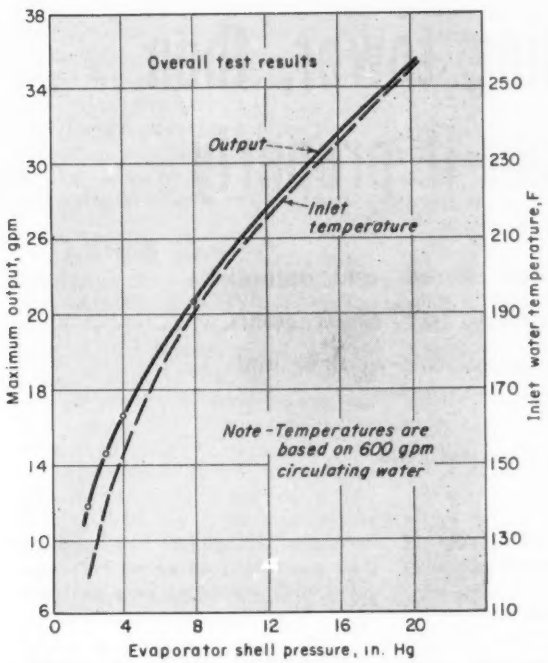
In this setup, all the conductivity cells are connected to a four-point recording Wheatstone bridge with manual temperature compensation. This records sample conductance directly. The cells measuring purity of the vapor sample, heater drain and condenser hotwell have a constant of 0.1 cm^3, while the cell in the sea-water loop has a constant of 10. Thus all cells are recorded on a single scale.

Test procedure. A series of runs were conducted at constant shell pressure for various sea-water inlet temperatures. On subsequent tests, shell pressure was changed and a new series of runs made for various temperatures.

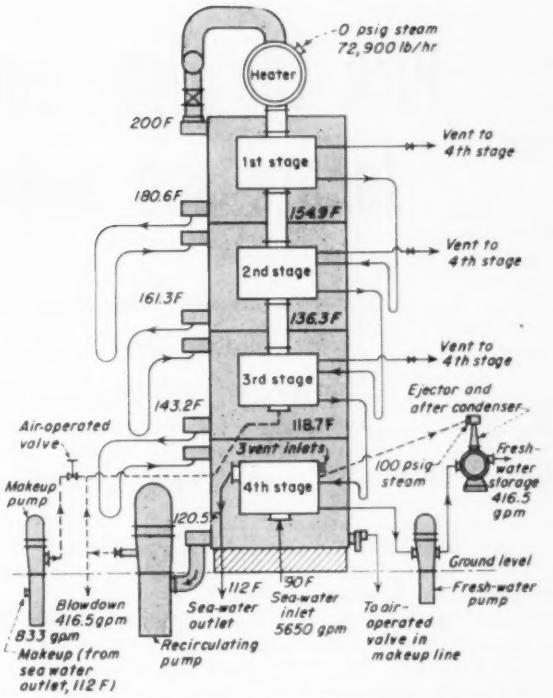
In our most recent tests we filled makeup system with sea water, trucked in from the Atlantic Coast. This water was pumped through the system. After establishing steady-state conditions, we operated system at least one hour before recording flow rates, temperatures, pressures and sample conductivities indicating dissolved solids concentrations. We also measured pressures and temperatures just above water line in the evaporator shell, at top of the shell outside the kidney-shaped baffle, and in the vapor offtake pipe.

Test results. One problem was determining effectiveness of flashing sea water as defined by equation (1). Fig. 4 shows a comparison between the measured evaporator sump temperature and the saturation temperatures for pure water for various shell pressures. Difference between the two is nearly 1.5 F. For a shell concentration of 37,000 ppm, true equilibrium temperature is nearly 1.0 F higher than for pure water in this temperature range.

So the unflashed portion of the water comes within 0.5 F of equilibrium temperature. This gives flashing efficien-



6 Overall test results for the experimental unit show the fresh-water output possible at various shell pressures



7 Proposed arrangement of a multistage flash-type evaporator would increase vapor output per unit heat input

cies of 90 and 97% corresponding to temperature drops caused by flashing of 5 and 30 F, respectively. So it appears this design can provide adequate atomization and vapor release time to reach almost complete equilibrium.

Fig. 5 shows performance characteristic of the separator nozzle. Drag force on a liquid particle can be expressed:

$$(2)\ F = C_D\ (\rho\, V^2/2g)$$

Where, F = drag force, lb_f/sq ft; C_D = drag coefficient; ρ = vapor density, lb_m/cu ft; V = vapor velocity at point of direction change upon leaving accelerator nozzle, ft/sec; g = acceleration of gravity, 32.2 ft/sec/sec.

Evaporator performance can be best represented in terms of the dynamic head, $\rho\, V^2/2g$. Fig. 5 shows that test data correlates fairly well by this type of representation. Note that beyond a critical dynamic head the solids content of the vapor increases sharply.

When you know the limiting critical dynamic head, you can calculate maximum evaporator output. For a given feed-inlet temperature you can obtain this maximum output by circulating a large amount of water using a small temperature drop (high-shell pressure) or less water with a large temperature drop (low-shell pressure).

Fig. 6 summarizes the overall test results. You can see that for a shell pressure of 4-in. Hg, the experimental evaporator yields 16.6 gpm water with a solids content of 150 ppm when feed-inlet temperature is 154 F.

Conclusions. Based on these preliminary studies, we conclude:

(1) The flash-type evaporator discussed above provides an economical means of producing potable water from sea water or polluted sources when a low cost heat source is available.

(2) This experimental evaporator is ideally suited for incorporating an internal condenser with a removable shell. Fig. 3. This arrangement would further simplify plant operation, eliminate piping losses and save space.

(3) The unit is adaptable to multistaging in a compact stack arrangement, further increasing its vapor output per unit heat input. Fig. 7 shows one proposed arrangement. This multistage unit would produce 2.86 lb of fresh water per lb of saturated steam at atmospheric pressure.

(4) You can use various waste heat sources to heat the low-temperature feedwater. For example: exhaust of open-cycle gas turbines, exhaust of standard steam turbines, low-pressure steam from waste heat boilers, moderately-hot water from final coolers on refinery heat exchangers (in this case the water heater can be eliminated). Another source is water heated by solar energy.

(5) Because of their extremely simple design features, integral condenser-evaporator package units may be manufactured at low cost. The system can be installed outdoors, to keep installation costs low. Operation and maintenance costs are at a minimum, and no complicated controls are necessary.

Pick the right cooling tower, then locate and maintain it properly

Here's helpful info about induced- forced- and natural-draft cooling towers: their location, air requirements, capacity and maintenance, with special cold-weather hints

By DONALD SWIFT, *Ebasco Services Incorporated*

► WHERE POWER-PLANT water supply for cooling and condensing is limited, a cooling tower or pond may be used to cut water consumption. Makeup to replace losses from evaporation, spray windage and blowdown is usually only 1 to 5% of the quantity circulated. This can often be supplied by wells or small streams.

Tower types. Based on the means for causing air flow, cooling towers can be classified as natural-draft, forced-draft or induced-draft types.

In general, air is moved horizontally or upward through the tower, while the water falls downward. For effective heat removal, the water is broken up into fine drops to give a large surface area. Sprays, baffles, cascading troughs, etc, take care of this.

Air absorbs the water's heat by conduction and by evaporation of a small percentage of water. The vapor formed mixes with and is carried away by the air as it moves through the tower.

Tower location. The large air flows needed to carry off heat, water vapor and water droplets introduce tower location problems. These increase with larger installations. Water-laden air forms veritable fogs and clouds. These may hamper traffic, cause heavy ice deposits on electric lines or salt deposits on high-voltage insulators or apparatus. *Result:* flashovers and arcing. If the vapor-laden air reaches adjacent buildings, moisture and the odor of chemicals used for water conditioning may be objectionable.

When locating a tower, consider the nearby hills, man-made structures and the prevailing wind direction. You must have free air flow to the tower and free vapor flow away from it, particularly when wet-bulb temperature is high. If more than one cooling tower is to be located in an area, consider the damaging effect of warm vapor-laden discharge from one tower being drawn into the inlet of an adjoining one.

For best performance, tower spacing must be reasonably wide and the units must be oriented carefully with respect to prevailing winds. Under certain conditions, a tower may even "blanket" itself; enough discharge air may be drawn into the air intake to materially affect the amount of cooling. So even if there is only one tower in the area, orient it for minimum recirculation.

The local weather bureau or the cooling-tower manufacturer can tell you the relative time winds normally blow from each direction.

Ordinarily, locate the axis of a forced- or induced-draft tower so prevailing wind in hot weather blows parallel or at a slight angle to it. Then fresh air can be drawn in on both sides; air forced out the top is carried over the lee tower sections and forced still higher.

A natural-draft tower is probably best located broadside to the warm-weather winds to get maximum air movement through it. The manufacturer can usually advise on the preferential tower orientation for a particular site. Take advantage of this service.

Induced-draft towers. At present, induced-draft towers seem most popular for larger installations. A large fan with vertical shaft is set at top of the tower. It draws air in from the sides. Air passes either across or counter-flow to the water, then is exhausted upward. This type tower, particularly the side-flow type, can be made relatively wide and low to reduce power for pumping water.

Fan diameter is quite large. To keep blade tip speeds within limits, fan ordinarily operates at 200 to 400 rpm. A worm or spur gear takes care of speed reduction.

Compared with forced-draft towers, induced-draft units have larger fans and tower cells, need fewer control circuits. Higher leaving velocity carries the warm, air-vapor mixture higher above the tower inlet openings and helps minimize recirculation. Fan noise is usually less annoying as it is directed upward.

Forced-draft towers are usually arranged as a series of cells with a horizontal fan on the side of each cell. Fan moves air toward the back of the cell. Air is then turned up by baffles, passes through falling water and out tower top through spray eliminators.

The full tower top area is used for

air discharge. So outlet velocity is low compared to an induced-draft tower. Fan diameter is usually not over 10 ft, so speeds of 900 to 1200 rpm are possible. This permits use of intermediate speed motors and direct drive. Larger fans with gear drive may also be used.

Eliminating speed-reducing gears avoids one source of trouble. The smaller fans also have less blade breakage. On the other hand, moist air recirculation may cause ice to form on the fans. Units must be watched closely in freezing weather to avoid damage.

Natural-draft towers occupy a larger volume per unit of cooling capacity than induced- or forced-draft towers, because air velocities are comparatively low and wind direction varies. Air-flow passages must be free and open for easy air circulation. Strong winds may then carry off large, troublesome amounts of spray.

Small-capacity towers are usually square. Larger ones are higher and longer. Units are oriented to expose the large face to prevailing winds.

Air requirements. Quantity of air and its flow pattern distribution in contacting the water determine cooling degree and efficiency. The more air, the closer the approach to theoretical lower limit of atmospheric wet-bulb temperature. But, for a given tower design, power to handle the air varies as the cube of air flow. So fan operating power is a limiting factor.

Fan-blade angle is usually adjustable. Thus power consumption can and should be limited to what the motor can safely stand. You can sometimes increase air flow with the same power consumption by increasing fan efficiency with a better blade design or by enlarging fans and running them more slowly. You can also decrease air flow resistance by changing tower baffling, fill or drift eliminators.

But reducing air-flow resistance may mean water surface available to contact the air is reduced, or air-water contact time is less. This could affect tower performance adversely.

Like any other heat exchanger, cooling-tower performance depends on temperature difference between air and water, surface available for heat transfer and its conductivity coefficients.

Determining actual air flow through a tower cell is rather difficult because of the large passage areas and flow variations. One way is to measure air velocity in segments of equal area at the outlet of an induced-draft fan or at the inlet of a forced-draft fan. You could make the same measurements on the inlets of an induced-draft or the outlet of a forced-draft unit, but the area is larger and working conditions are poorer.

Anemometer readings are usually better at the higher-velocity locations first mentioned, although you may encounter a reverse flow near the fan hub. Also consider the effect of temperature and water vapor content on the actual weight of air handled as determined by velocity measurements.

Another way to get a rough air-flow check is to check power input to the fan. This reflects the weight of air being handled. Measure current to the motor with a portable ammeter if there is not a separate ammeter for each motor. Check voltage at the same time. Voltage variations affect current drawn for a given motor load. It is usually economical to load the motors up to rated current.

Most fans have adjustable pitch blades so the bite may be changed. See that all blades in a given fan are set at the same angle.

An indirect way to measure cooling-tower air flow is to work out a tower heat balance. This involves measuring water pumped and temperature rise or range over the tower, with a correction for makeup water added. Measuring wet- and dry-bulb temperature of tower inlet and outlet air (the latter taken at a number of points, as in a velocity survey) establishes enthalpy of the inlet and outlet air. Heat transferred in the tower divided by enthalpy rise of the air establishes pounds of air passing through the tower. This is an overall figure for the tower and conditions in individual cells may vary considerably from the average.

A survey of air leaving temperatures often reveals surprising temperature variations, even in a single cell. These variations may come from either stratified air or water flow. You may find excessive water flow in some spots and lightly-loaded areas elsewhere. Checking with an anemometer may help track down the trouble.

Other causes of trouble: air baffles out of place; air louvers or spray eliminators broken, missing or caked with algae; tower fill broken, out of place, plugged with algae or debris; wind direction adversely affecting air flow and causing recirculation. Increased flow on the windward side and decreased flow on the lee side as caused by a side wind is not particularly harmful unless recirculation occurs.

For best performance, air flow should be at a maximum, with no recirculation and with uniform leaving-air temperature.

Water distribution. Water flow over a cooling tower should be uniform, with the water dividing into fine droplets and with falling time through the tower as great as possible. A large wetted surface area is also helpful.

Many arrangements are used to achieve these objectives. The higher the tower, greater the falling time. But pumping head sets an economic limit to tower height. One of the simplest water-distributing systems is a network of spray pipes near the tower top. Water sprays out uniformly in fine droplets and falls into the tower basin. But you need at least 10 psi to break up the water into fine drops. Falling speed increases, of course, as droplets are affected by gravity. So time available for contact with the air is short.

To increase air-contact time, tower designers use a series of baffles or shelves, or finely-interlaced strips. These break and slow the water's fall. Known as tower fill, these obstructions are usually made of wood. Their arrangement varies, depending on the design idea. Take care that fill is not so dense as to seriously retard air flow.

It is always difficult to attain uniform water flow over a tower. Even if all portions of a water-distributing system are similar the water tends to move in the direction it is flowing. This robs those sections where a change in direction is required.

There are usually valves to shut off individual tower sections. Adjust these for equal flow to all sections. If water is distributed by troughs, manufacturer usually provides some form of gate or weir to further adjust water flow. Often, main inlet troughs spill over. This causes a heavy concentration of water with no chance for adequate cooling. In towers with water-distributing pools fed by one main pipe, water velocity often results in a higher level over one side or the outer edges of the pool. Sometimes you have to put smaller orifices in the outer edges of the pools to compensate for the increased water depth.

Water-distributing orifices in the bottom of distributing troughs or pools are subject to plugging from leaves, debris and algae growth. Inspect and clean periodically while water is shut off. Water from the orifices usually falls on some form of splash plate or disk de-

(Continued on page 188)

By M R SKROKOV
Field Engineer
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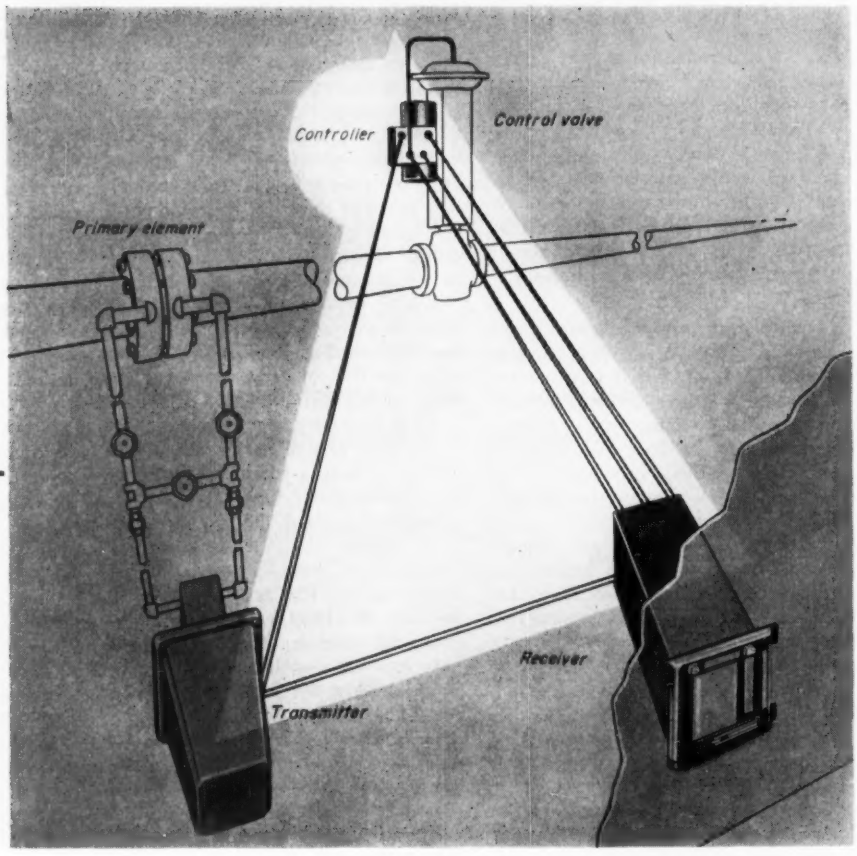


Third article in a series on flowmetering

Flow controllers

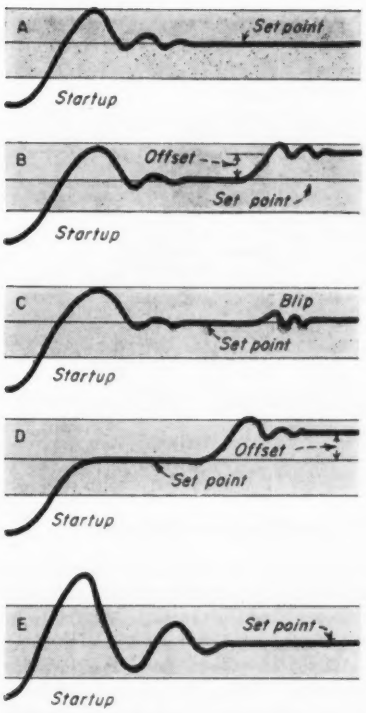
► THE CONTROLLER in flowmetering systems responds to signals received from the transmitter, or directly from the primary elements, and actuates a valve to keep flow rate at a pre-established value. It is the third link in the flow-control chain. Primary elements were discussed in POWER, Feb 1956, pp 100-103, and transmitters in Aug 1956, pp 94-97. Location of controllers with respect to other parts of the system is taken up in second of these articles. Input signals directly from primary elements may be used where transmission distances are short. Electric-transmitter signals have not yet gained popularity because of limitations of electric throttling valves, although wider use of mass spectrometers and infrared analyzers in process quality control will stimulate application of electronic systems. Present practice favors pneumatic signals that have been amplified by the transmitter. Pneumatic output signals of controller reposition throttling control valve to correct flow rate according to the pre-established set point.

Ways in which controller in pneumatic circuit responds are classified as (1) proportional response (2) automatic-reset response (3) derivative response. Features of these three responses are summarized in table at top of facing page.

Proportional response. This is simplest of three types of response, and the others are based upon it. With proportional response, controller gives *valve* movement proportional to *pen movement* (controller input signal). *Example:* If pen moves through 10% of chart it would give twice as much valve movement as a 5% pen movement. *Sensitivity*, a measure of proportional response, is ratio of valve movement to pen movement. *Throttling range* is ratio of pen movement to full valve travel. In pneumatic controllers, a given sensitivity produces a rate change of output (valve-operating) air pressure proportional to rate of pen movement. Stated mathematically:

$$P - P_o = S(X - X_o),$$

where P_o is original output pressure in psi, P is new output pressure, X_o original pen position on chart, X new pen



RESPONSE CURVES. *A* shows proportional response where there is no load change, while *B* shows what happens with a load change when controller lacks reset response. Controller *C* has automatic reset; small "blip" occurs where offset would be. Derivative response is shown for temperature application in *D*; curve *E* for a derivative flow application.

Summary of control responses

	Proportional	Automatic reset	Derivative
Action	Valve movement / Pen movement	Valve velocity / Pen movement	Valve movement / Pen velocity
Measure	Sensitivity	Reset rate	Rate-action time
Units	Psi per inch	Repeats per min.	Minutes
Remarks	Some variation of this response is needed on all controllers	Ideal for load changes on flow	Can't be used on majority of flow aplications

position and S the constant of proportionality. If change of output pressure occurs over period of time:

$$\frac{P-P_o}{t-t_o} = \text{avg rate of change of } P,$$

$$\frac{X-X_o}{t-t_o} = \text{avg rate of change of } X.$$

First equation can be rewritten:

$$\frac{P-P_o}{t-t_o} = S\left[\frac{X-X_o}{t-t_o}\right] \quad \text{or}$$

$$\frac{dP}{dt} = S\ \frac{dX}{dt}$$

since small differences in output pressure or pen movement can be written as differentials.

This mathematical presentation pinpoints origins of terms *sensitivity* and *throttling range;* helps explain what happens in a controller when S is varied. The sensitivity adjustment, usually a knob, is variable over a wide range. Units of sensitivity are shown to be psi per inch, and if a low value of sensitivity were tuned into controller, for example, one psi per inch, output pressure would change only one psi where pointer or pen moved one inch on chart. With this setting, controller is operating over a broad band and stability is easily achieved. With S set at a high value, say 300 psi per inch, output pressure changes one psi when pointer moves through only 0.0033 in. This places control in a narrow band and approximates on-off action when valve moves from fully open to fully closed position in attempting to maintain control. In most cases controller is best tuned to process with S somewhere between these two settings.

Automatic reset response. This control function detects any offset (error) between pen (momentary flow rate) and set point (desired constant flow rate) and produces a slow, continuous valve movement in proper direction to correct offset. The *rate* of valve movement is proportional to the offset or linear chart distance between pen and set point. Automatic-reset response gives valve velocity proportional to *pen displacement from set point;* proportional response gives *valve displacement* proportional to *pen displacement.* Mathematically, automatic reset can be expressed as:

$$\frac{dP}{dt} = K\ (X - X_o)$$

where dP/dt represents rate of change of output air pressure; $(X - X_o)$ is offset; K is a proportionality constant that is function of sensitivity, S. If a new constant R is introduced to represent reset rate (a measure of automatic reset present in controller) then $K = RS$, and:

$$\frac{dP}{dt} = RS\ (X - X_o)$$

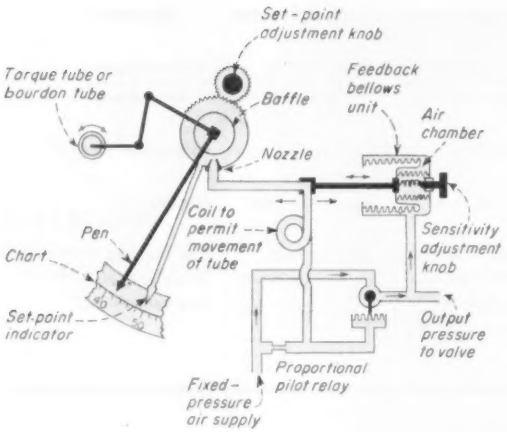
Reset rates are available from 10 to 0.1 repeats per minute. Reset rate necessary for a given application is tuned into controller only after some sensitivity stability has been achieved.

Derivative response. This control function provides additional *valve displacement* proportional to *rate of pen movement.* Derivative response anticipates corrective action necessary. A measure of derivative response is *rate-action time* expressed in minutes. Valve displacement is equivalent to change in output pressure of controller, which, when proportional to rate of pen movement, can be expressed mathematically:

$$P - P_o = K_d\left[\frac{dX}{dt}\right]$$

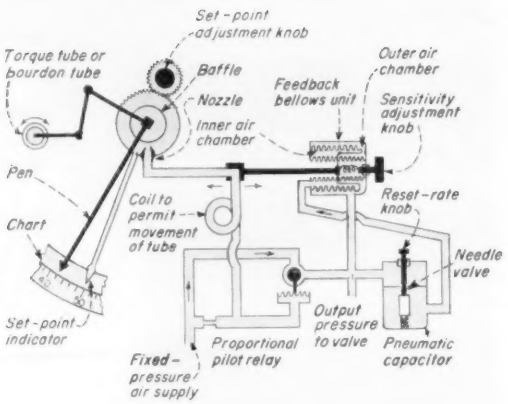
where K_d is derivative-response proportionality constant. $K_d = TS$, T representing rate-action time which can be adjusted in controller.

Derivative response is used mainly on temperature applications where overpeaking on startup is to be prevented. Flow applications are ordinarily too fast for derivative response to catch an overpeak; automatic-reset is more valuable as it does correct offset. Generally, fast processes require low-sensitivity settings and a healthy reset rate. Slow processes, such as jacketed-chemical-kettle temperature control applications, require high sensitivity and fast rate-action-time settings. *Turn page*



1. Proportional response

Input signal, converted to mechanical rotation by a torque tube or bourdon tube, drives pointer (or pen of recording instrument), and positions baffle with respect to nozzle. Nozzle-baffle relationship determines air backpressure which actuates air relay. Air relay amplifies signal to actuate valve. Feedback is provided by bellows unit that positions nozzle with respect to baffle. Sensitivity is manually set into feedback bellows. Set point is adjusted through gears and linkages associated with pen and baffle mechanism. Response curve *A*, preceding page, illustrates action under steady load, shows normal starting oscillations.



2. Automatic reset response

Basic mechanism is same as for simple proportional response, but pneumatic capacitor has been added and feedback bellows modified. Pneumatic capacitor is fed from output signal and introduces a time-lag component into feedback bellows to compensate for time-lag in the process. Reset rate is adjusted by a needle valve in the pneumatic capacitor. Curves *B* and *C*, preceding page, show effect of automatic reset in a circuit where there is a load change. *Example:* Change of flow in process where pressure was being controlled. You tune controller by turning the reset-rate knob. The curves are based on highest sensitivity.

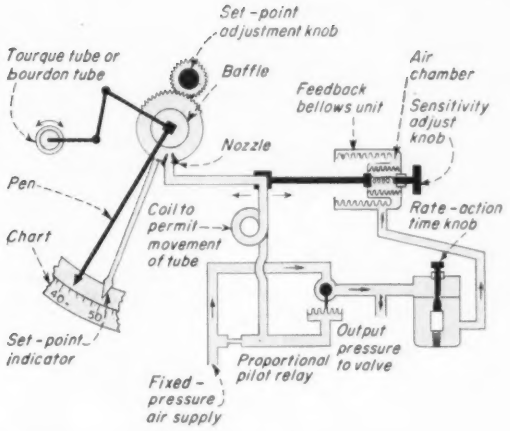
How typical pneumatic controllers give desired responses

Controller mechanisms. Controllers that use energy of input signal to actuate control valve are rarely applied to flow control. They are better suited to temperature and pressure regulation. Flow controllers are generally pilot operated, that is, input signal from transmitter or primary elements operate a relay in controller, and a secondary medium — air, hydraulic fluid or electricity — actuates control valve. Leading pneumatic types are described on these pages.

If input signal comes directly from primary elements it is converted to mechanical motion by a torque tube as it enters controller. Pneumatic signals from a transmitter or gas thermostat are converted by a bourdon tube. Fundamental controller mechanism is essentially like transmitters discussed in previous article but elements are added to obtain desired responses. A source of constant-pressure air, usually at 20 psi, an air relay and an air backpressure regulating device are basic components. Air backpressure device may be nozzle-baffle arrangement, swinging vane or swinging jet. A feedback circuit determines response and specially designed bellows and pneumatic capacitors introduce sensitivity, reset rate and rate-action time.

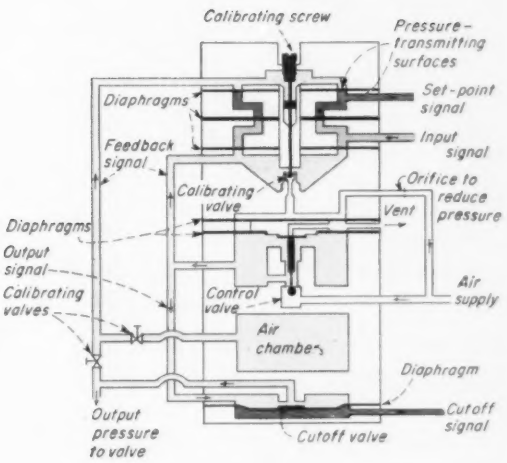
On-off response is function of simplest controller. Only adjustment is for calibration. There is no feedback bellows; output air signal is piped only to control valve and is not used to reposition nozzle. No adjustment for sensitivity is provided. Other types of controllers can combine proportional, automatic-reset and derivative responses. When all three are built into controller, pneumatic capacitors are in parallel across output line and bellows is the type used in automatic-reset controllers. Generally, in selecting values of automatic-reset and derivative responses necessary to control a given process, match process time lags with time lags built into controller. When the two match, the instrument is doing a good job in controlling the process. Process time lags are heat-transfer time through kettle wall, friction loss in pipeline, transportation lag (time required to send control signal) and capacity lag (such as that due to large-volume kettle), to mention a few typical examples.

Miniature instruments. Since World War II miniature instruments have been developed as a result of special problems solved during the war. They require less space, are more accurate and demand less maintenance. The force-balance transmitter, discussed in the preceding article, replaced usual gas- or liquid-filled bourdon measuring system; the blind stacked-diaphragm



3. Derivative response

Pneumatic capacitor is in series with signal from output to feedback bellows, thus introduces desired time lag. Derivative response prevents overpeaking in "slow" processes, such as most temperature applications, curve *D*, on p 99. Note that there is an offset if controller does not include reset response. Curve *E* shows what derivative response might do at startup in a flow (relatively "fast") application. In most cases it would amplify starting oscillations. After startup point is passed, proportional response (normally included in controller) will correct condition, assuming correct sensitivity has been tuned into the controller.



4. Stacked-diaphragm controller

Rubber diaphragms and system of ports in metal cylinder perform functions of mechanisms in conventional controller, except for direct indicating. Controller, above, includes automatic reset and proportional responses. Set point is adjusted by pneumatic signal from remote panel. Input signal representing process variable is introduced through another port. Variations in input signal causes movement of diaphragms which, in turn, actuate ball control valve of built-in air relay. Part of output signal is reintroduced across diaphragms to provide feedback. A cutoff valve cancels output signals on signal from the remote panel.

---

controller replaced controlling mechanism of old basic instrument; the miniature indicating or recording control-panel station carried the dial or chart and the set-point adjustments. Stacked-diaphragm controller, above, operates on force-balance principle. Motion of the diaphragms in order of 0.0001 in. represents wide range of process variable—(perhaps 100 F in temperature application). Controllers are easily replaced for repairs. Their connections can be plugged into place without upsetting set point and control point settings. These air signals are locked into circuit.

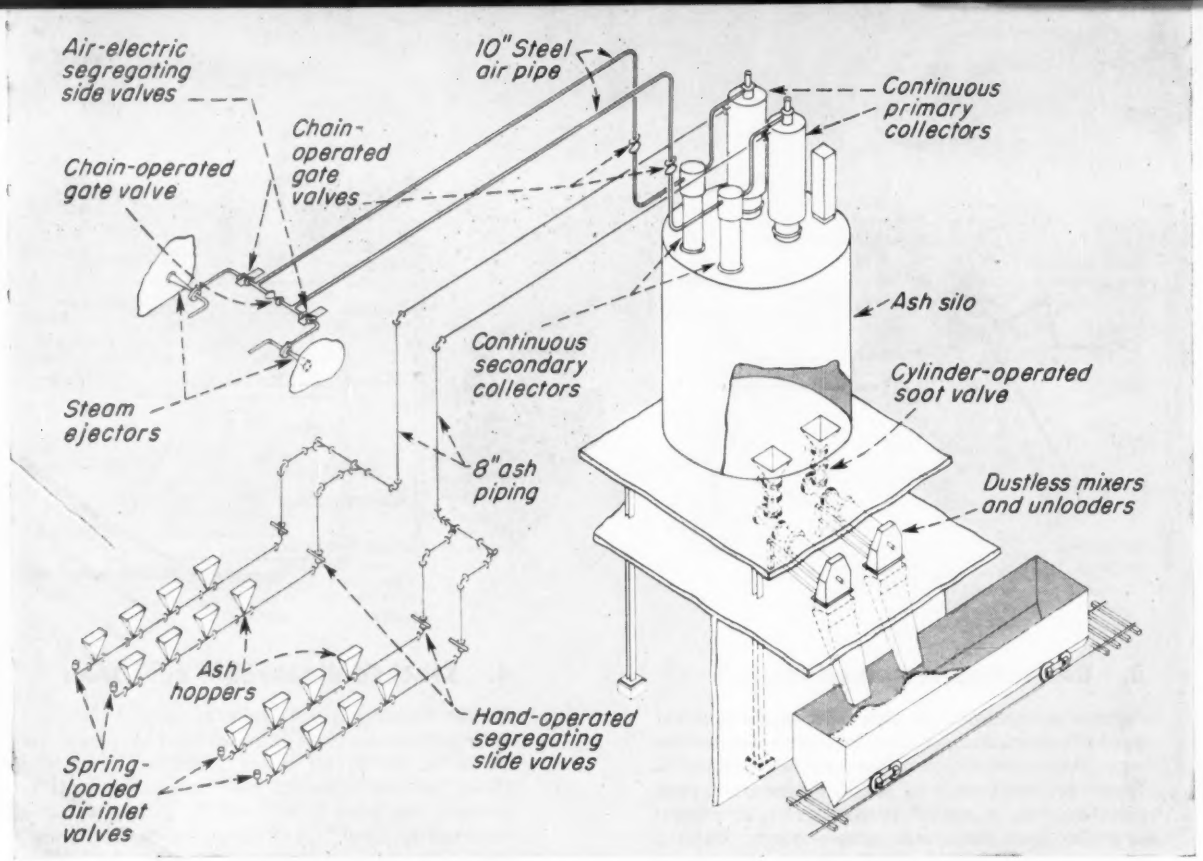
Stacked-diaphragm controllers usually combine proportional and automatic reset response but not derivative response. Latter is not generally useful in flow applications. Where desired an auxiliary stack is attached to combine the three responses in one controller.

Miniature instruments are gaining popularity, especially in large flow-measuring installations where many instruments must be incorporated on one panelboard and where accuracy and maintenance facility are important. Costwise, miniature circuits—transmitters, controllers and receivers—compare favorably to older instrumentation. In flow application the older method could be more expensive considering use of mercury manometers and automatic reset.

Special controllers. Some process control problems require more than the three responses to achieve control. *Example:* Some batch operations need control over a definite period, after which process must be shut off. A timer is incorporated into the controller to make a *process timer*. Another process may require that set point be varied automatically. This is accomplished by a *time-schedule controller* that automatically adjusts set point according to a cam cut to follow a plot of process variable.

Ratio controllers are designed to control ratio between two variables. *Example: Flow-ratio controller* senses two independent differential pressures, limits one with respect to the other to maintain a ratio of, say, 1 to 4. Temperature ratios can be set in this manner as well.

Master controllers, utilizing pneumatic setting, can be made to control several variables. *Example: Liquid-level controller* (master) pneumatically sets controller's set point and regulates steam flow. Ordinarily liquid-level instrument could operate steam valve directly, but variations in steam pressure, pumping head or downstream pressure would cause undesirable fluctuations or oscillation in the flow rate.



Unique features blended into an ash-handling system design provide...

First pneumatic ash system under a pressurized furnace

By **R W HORN**, *Chief Engineer, The Allen-Sherman-Hoff Co*

► JOB SPECIFICATIONS called for pneumatic ash-handling when the Philadelphia Electric Company recently added two 125,000-kw turbine-generators and two 875,000-lb-per-hr boilers to their Delaware Station.

Normally, there wouldn't be anything unusual in such a specification. But the new, pulverized-coal-fired steam generators were to operate with a positive furnace pressure of 20 in. of water. And pneumatic ash-handling had never before been used with a pressurized furnace.

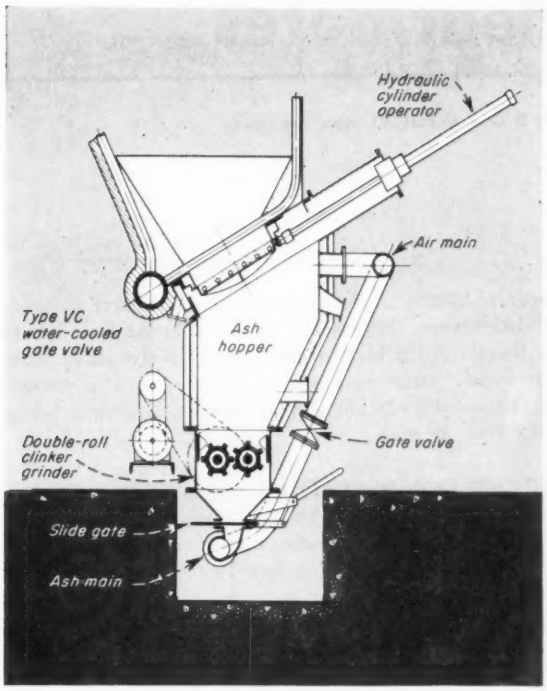
Further, the utility specified dry handling to avoid the remotest possibility of polluting the Delaware River. Another design problem was that an exceptionally heavy metallic-like slag had to be conveyed.

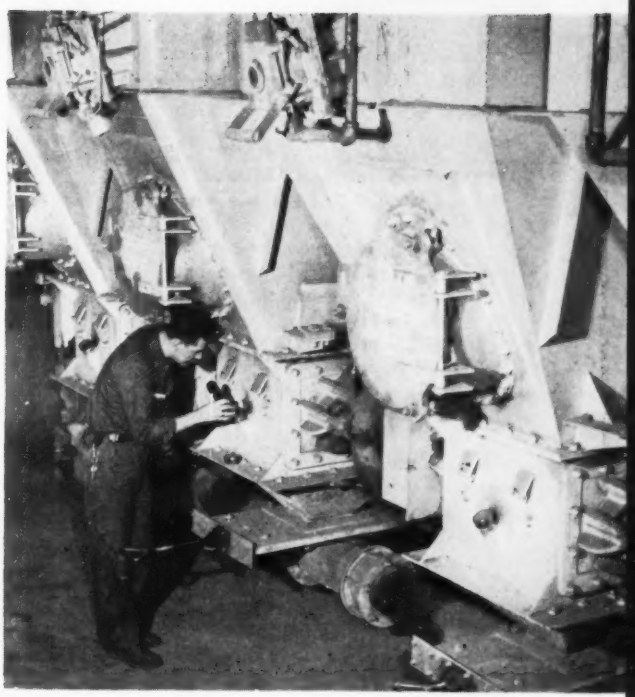
Installation. Sketch, above, shows schematically how system was installed. It's totally enclosed, prevents escape of hot gases and dust to the atmosphere. Ash, accumulated in a large bin, is moistened during discharge into railroad cars. This completely eliminates air and stream pollution.

Each boiler has a divided furnace with eight ash-discharge openings, four on either side of the boiler center line. Ash discharges by gravity through one opening at a time into hoppers. Under these, clinker grinders size the ash for transport. These grinders also feed the ash into the pneumatic conveying pipelines that are under vacuum created by steam ejectors, sketch, above.

Cyclone collectors, mounted on top of a storage bin, separate ash from conveying air, automatically discharge it into the silo. Piping run from each boiler to the separators is 230 ft, including 85 ft of vertical lift. A 20 ft diameter steel ash storage bin, with two mixer and unloader units, is common to both boilers.

Ash-hopper assembly. Sketch, p 103,





. . . water-cooled ash-hopper gates . . . grinders for metallic-like slag

shows in simplified form, each ash-hopper assembly. Operator controls ash discharge through each furnace bottom opening by a hydraulically operated gate designed for high-temperature conditions. It's water cooled by means of tubes embedded in the refractory lining of the ductile iron door.

The door frame also is ductile iron, cooled by air circulating through it and bled into the furnace through small orifices. Wedging cams seat machined surfaces of door and frame in intimate contact when closed. The juncture is also sealed by the cooling air.

Welded steel plates, lined with monolithic refractory, comprise the hopper. Gate, hopper, grinder and piping join to make an air-tight unit suspended from the boiler structure. Each hopper has a 20 in. diameter access door and a pressurized poke-hole door for lancing the opening in the furnace bottom. Air jets counteract pressure in the hopper when this door is open.

Beneath the hopper a double-roll clinker grinder sizes the ash, feeds it to transport piping. Five-hp motors, hydraulically coupled to speed reducers, drive grinders in pairs, but only one handles ash at a time. Under each grinder, a hand-operated 8-in. slide gate controls transport-pipeline inlet.

An 8-in. air duct connected to each hopper chamber, above, left, supplies air at a pressure higher than that in the furnace. This keeps hot gases from the hopper when the ash gate is opened. The duct, also connected to the ash piping, gives a helping boost to the vacuum pull in the system.

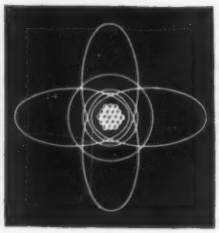
Ash-transport piping and fittings are *Ashcolite* (a hard chrome-iron alloy) with air-tight sleeve couplings. Two types of fittings used are: (1) integral wearback (having an integrally-cast thick wear section) for moderate-wear. (2) impact (having replaceable chrome-iron wearbacks), for severe-wear due to high velocity.

Hopper group branch line valving confines operating area to a single group, provides maximum vacuum at the ash-handling hoppers.

A pair of cyclone collectors for each boiler separate ash from conveying air. Each pair is a two-cell primary and a smaller two-cell secondary collector. The two-cell construction cuts operating time by functioning to collect and dump at the same time. A cycle timer controls operating sequence of positive-acting dump grates.

Separate steam ejectors produce vacuum on the two collector systems, exhausting steam to the flue. Steel air piping, 10-in., connects ejectors to collectors. Each ejector air line, sketch, p 102, has an air-electric-operated segregating slide valve and a chain-operated gate valve, plus a chain-operated valve in the crossover between the ejectors. This allows cross-connection of either ejector with either ash-transporting system.

A bag filter, housed in an outdoor aluminum structure, vents the ash storage bin into which the collectors discharge. Ash flows by gravity through two 12-in. diameter air-operated cutoff slide gates designed to prevent jamming and plugging. Two rotary mixer and unloader units under the bin moisten the ash and unload it via hinged chutes. The wearplate-lined discharge chutes have air-operated hoists to raise them when not in use.



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Non-nuclear "bugs" delay the scheduled startup of the Homogeneous Reactor Experiment No. 2 at Oak Ridge National Laboratory. Microscopic cracking in the leak detector system tubing and possibly on flanges of the high-pressure system is the cause. These stainless steel parts will be replaced. Stress corrosion of stainless steel in presence of chloride ion contamination caused the cracking. This materials problem has no relation to nuclear reactor systems as such.

Argonne Boiling Reactor (ARBOR) will be designed and operated by Argonne National Laboratory for the AEC at the National Reactor Testing Station in Idaho. This unit will supplement work in the current boiling-water reactor program. The facility will cost about $8.5 million and start running in late 1959.

Uranium production in the U.S. is now handled by 12 mills with a total capacity of 8960 tons of ore per day; 11 are privately owned. Estimated investment in these plants totals $50 million. Eight new plants to start in 1957 and 1958 will have total capacity of 4025 tons per day and cost about $35 million. Ore production during 1956 totaled 3 million tons; this compares with total domestic ore reserves estimated at 60 million tons containing 0.25% of U_3O_8. About 41 million tons lies in New Mexico and 7.5 million tons in Utah.

More declassification of nuclear information will be undertaken by U.S. in agreement with Canada and United Kingdom during the next six months. About one-third of 30,000 documents had been released under previous agreements. Remaining 20,000 will be re-reviewed, plus new ones prepared since original review. Information covers reactors, radiation effects, metallurgy, chemical processing, heavy-water production, raw materials and uranium isotope separation.

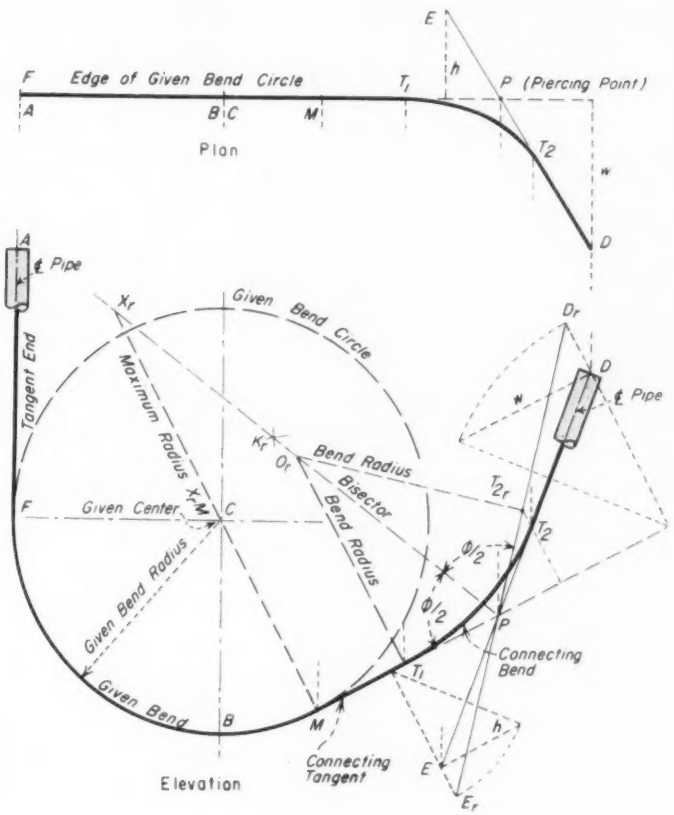
Proposed expansion of the Power Reactor Demonstration Program was announced by AEC Chairman Lewis L Strauss before the winter meeting of American Nuclear Society. He would like to see AEC sponsor five additional power reactors: (1) Natural-uranium fueled, heavy-water moderated, not less than 100-mw electrical capacity (2) fluid-fueled with aqueous solution or slurry or both of uranium or thorium or both, at least 100-mw electrical capacity (3) three small-scale reactors of varying new design. Strauss also proposes that additional help be given present and future private participants by additional government-paid research and development.

Reactor census as of Oct 1, 1956 for U.S. released by AEC shows an impressive scope of activity in the field. Here's the count: completed, later dismantled—14; completed and existing—68; under construction—49; planned—83; total of all reactors—214. This count includes 131 low-temperature reactors and 83 high-temperature power reactors. Only 17 of these will be full-scale civilian power reactors in U.S. and 6 will be for foreign installation. This compares with 27 full-scale military power reactors.

Team work? At one time the fuel-element designer worked completely at cross-purposes with the fuel processor. This conflict still persists in some projects where the processing people are not integrated in the work. Fuel elements that will not be attacked or corroded by anything are bound to be hard to process and may increase the cost of processing to prohibitive levels—By W K Davis, Director of reactor development, U.S. Atomic Energy Commission.

Power's DATA SHEET

No. 296



Pipe-bend design

► PIPING DESIGN TREND to welded joints and pipe bends in place of flanged pipe and fittings allows more design flexibility and material economy. But time-wasting trial-and-error design methods are still widely used. Here is a direct way to design one type pipe bend, accurately dimensioned, with minimum material.

Problem. Steam line leaves turbine casing in a downward direction. We must clear foundations or change direction and join a pipe run in another direction. Problem is then to connect a given circle to a straight line in a different plane with a smooth arc. To be obtained are: (1) angle of bend (2) center of bend (3) tangent points and (4) maximum connecting bend radius. The answer will tell us when maximum radius is less than practical bend radius or if solution is impossible.

Drawing shows elevation and plan view of pipe bend. Initial circle bend is centered at *C* with radius *CF*. Starting tangent *FA* is typical. Other end of pipe goes along *ED*. Circle *C* appears as straight line *ABCM* in plan view. and true size in elevation. If the edge view and true size vertical view are not given, they can be set up in auxiliary projections.

Solution. The connecting arc must start along a line tangent to circle *C* and end tangent to *ED*. Its plane is fixed by the intersection of these two tangents at *P*. First find piercing point *P* in plan view where *ED* pierces the plane of circle *C*. Then spot *P* along *DE* in elevation. Erect tangent from *P* to circle *C* to fix tangent point *M*. Angle *MPD* contains connecting arc but does not show true size. So another projection is needed.

Revolve line *ED* about true length axis *MP*. See dotted line construction. As *ED* moves into the plane of circle *C* in plan view, points *D* and *E* travel distances *h* and *w*. In elevation, point *E* revolves to E_r and point *D* to D_r. Point *P* is fixed. Line E_r *P* D_r is now true length of *ED*. True angle of connecting arc is MPD_r and is independent of connecting arc radius.

Bisect bend angle ∅ with PK_r. Connecting arc is centered on PK_r at some point O_r. Erect perpendicular from O_r to lines *MP* and E_r *P* D_r to obtain bend radius O_r T_1 and tangent points T_1 and T_{2r}. Counter revolve tangent point T_{2r} *to* T_2. Then spot T_1 and T_2 in the plan view. Include short connecting tangent MT_1 to aid fabrication. Resulting bend is now possible to completely dimension. It appears as an ellipse in the two main views.

Construct a perpendicular to line *MP* at *M*. This intersects extension of K_r O_r *P* at X_r to give maximum bend radius X_rM. Since bend starts at *M* the connecting tangent is zero. As X_r moves toward O_r, the bend radius decreases and connecting tangent increases. Zero radius gives a sharp corner at *P*. So piercing point *P* must be located some distance outside the circle. Good piping design calls for bend radius three to five times pipe diameter.

If *ED* does pierce the circle plane at, or inside, the circumference, solution is impossible with a single connecting bend. First try moving original circle bend away from *DE* and shortening its radius. If this is not enough, then a more complicated double-bend design must be used. When initial line *AF* happens to intersect line *ED* a single continuous bend can be constructed tangent to these two lines.

PHILIP O POTTS,
University of Michigan

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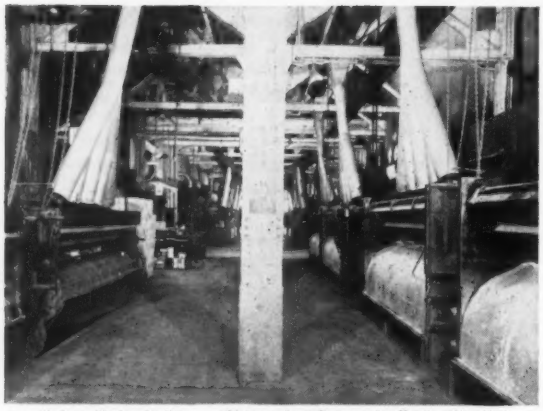
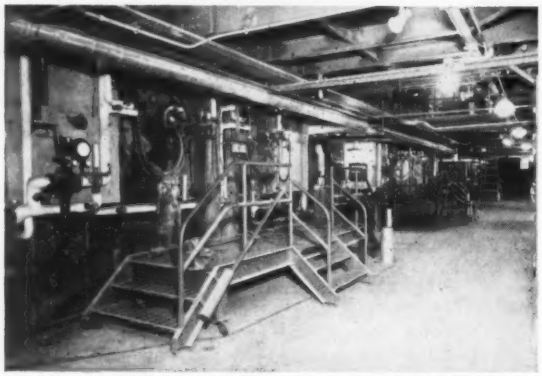
THE MODERNIZATION OF

gives *Western Electric Company*

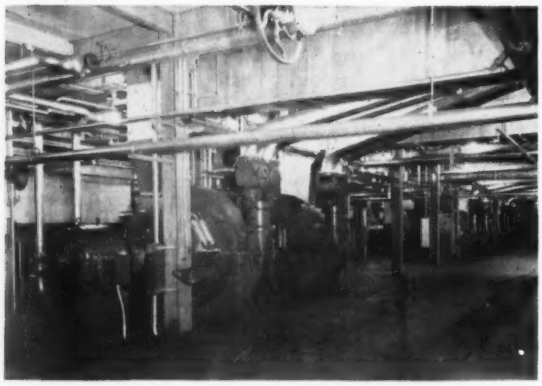
more power per worker at 40% less cost and an annual savings of $500,000



Before Modernization — Sixteen traveling grate fired units that were replaced by three Riley Units.



After Modernization — Firing Aisle of new Riley installations that feature Riley Flare Type Burners.



Six Riley "50" Pulverizers assure sustained high fineness of the Illinois and Indiana coals used at Hawthorne. Riley Pulverizers are noted for their quiet vibrationless operation and their ability to operate efficiently with the wettest coals.

When faced with a continually increasing annual expense for energy production in relation to number of workers, officials at Western Electric Company's Hawthorne Works at Chicago, Illinois decided that investment in modernization was needed. Their final selection of equipment was based on facts developed in exhaustive studies of heat cycle and labor costs.

The three Riley 150,000 lbs/hr. Units that were installed, replacing sixteen small boilers, are equipped to burn coal, oil or gas to supply steam for all manufacturing and plant services independent of outside sources. The services are distributed as steam, electric power, compressed air and hot water for space heating.

UNITED ENGINEERS & CONSTRUCTORS, INC.
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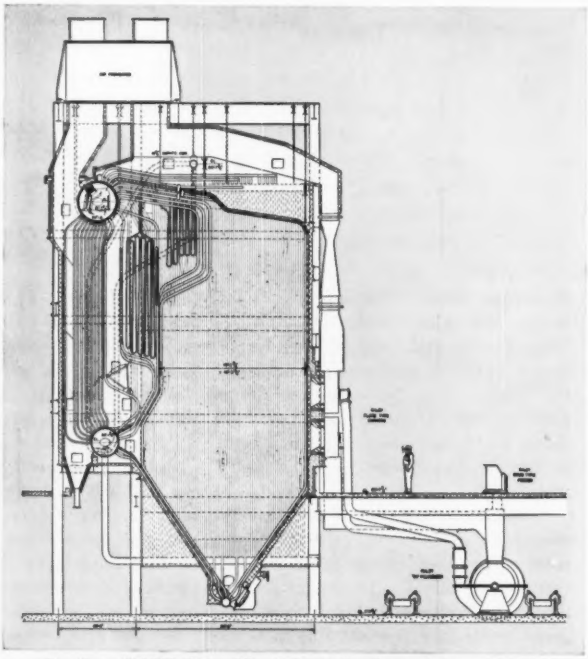


The three 150,000 lb/hr. Riley Units at Hawthorne feature patented Single Header Hopper Bottoms. Furnace is designed for coals with ash fusion temperatures as low as 1900 F. Steam Pressure 1000 psig., temperature 835 F.

HAWTHORNE POWER PLANT

Power MODERNIZATION PROGRAM

Since completion of modernization, operating results thoroughly justify Western Electric Company's findings and the amount of its investment:

HIGHER EFFICIENCY

Three 150,000 lbs/hr. Riley Boilers that replaced sixteen old units operate at efficiencies of 85% as against 67%.

LOWER FUEL COST

Cost of fuel has been reduced 40%; coal used has been Southern Illinois or Indiana carbon and screenings with no difficulties experienced with ash removal and furnace slagging; furnaces stay clean even when ash fusion temperatures are as low as 2000° F.

HIGH AVAILABILITY

Each unit rated at 200,000 lbs/hr. peak capacity has operated successfully as high as 240,000 lbs/hr. in tests and has been available 98% of the time.

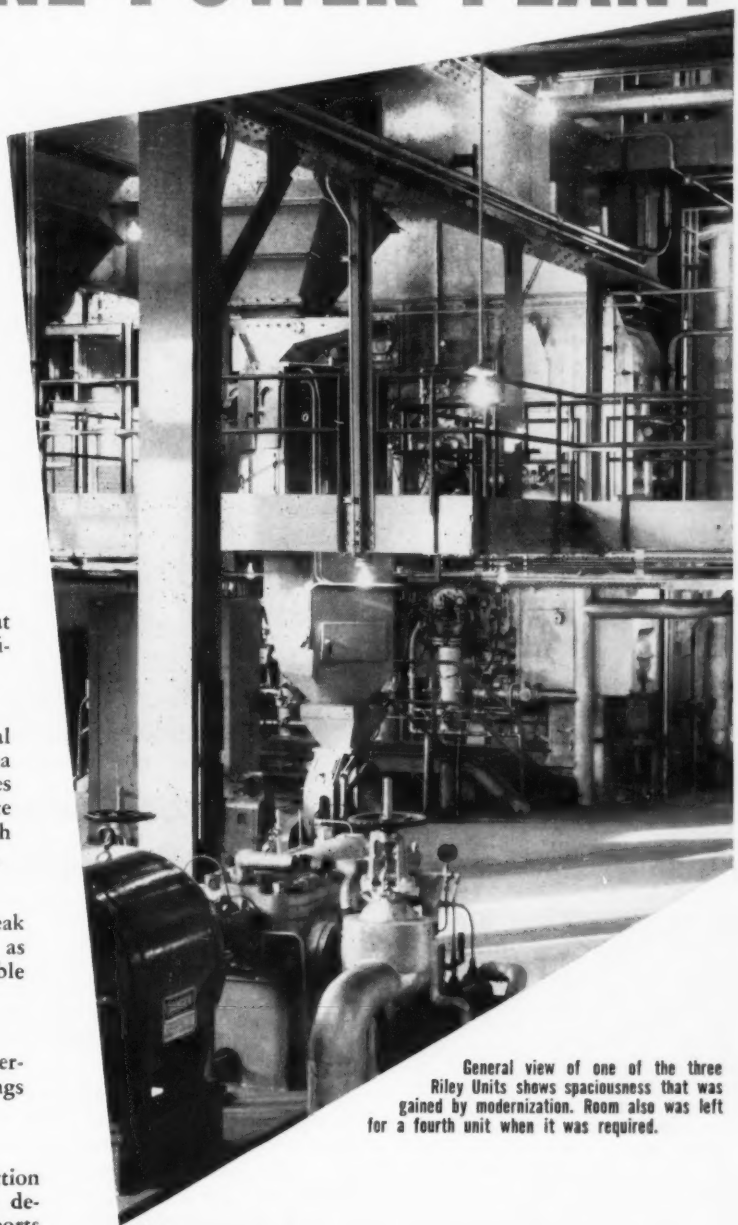
LOWER OPERATING COSTS

A 50% reduction in plant operating personnel was affected with maintenance savings amounting to $100,000 annually.

INCREASED SAVINGS

Basis for modernization was a production level equivalent to 23,000 kw maximum demand and 45% load factor. Recent reports show demand at 26,000 kw with 48% load factor, resulting in a total annual savings after fixed charges of over $500,000.

THESE FACTS PROVE that it pays to modernize . . . and with Riley Steam Generating and Fuel Burning Equipment. Furthermore . . . of the seventeen recipients of POWER'S Modernization Awards of 1954 and 1955, seven featured Riley Units complete with Riley Fuel Burning Equipment. They are: Western Electric Co., Iowa-Illinois Gas and Electric Co., Bendix Aviation Corp., Carbide and Carbon Chemicals Co., Garlock Packing Co., The Flintkote Co. and Pennsylvania R. R. Company. In the 1956 contest both Allis-Chalmers and Thomas A. Edison Co. joined the ranks.



General view of one of the three Riley Units shows spaciousness that was gained by modernization. Room also was left for a fourth unit when it was required.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

RILEY

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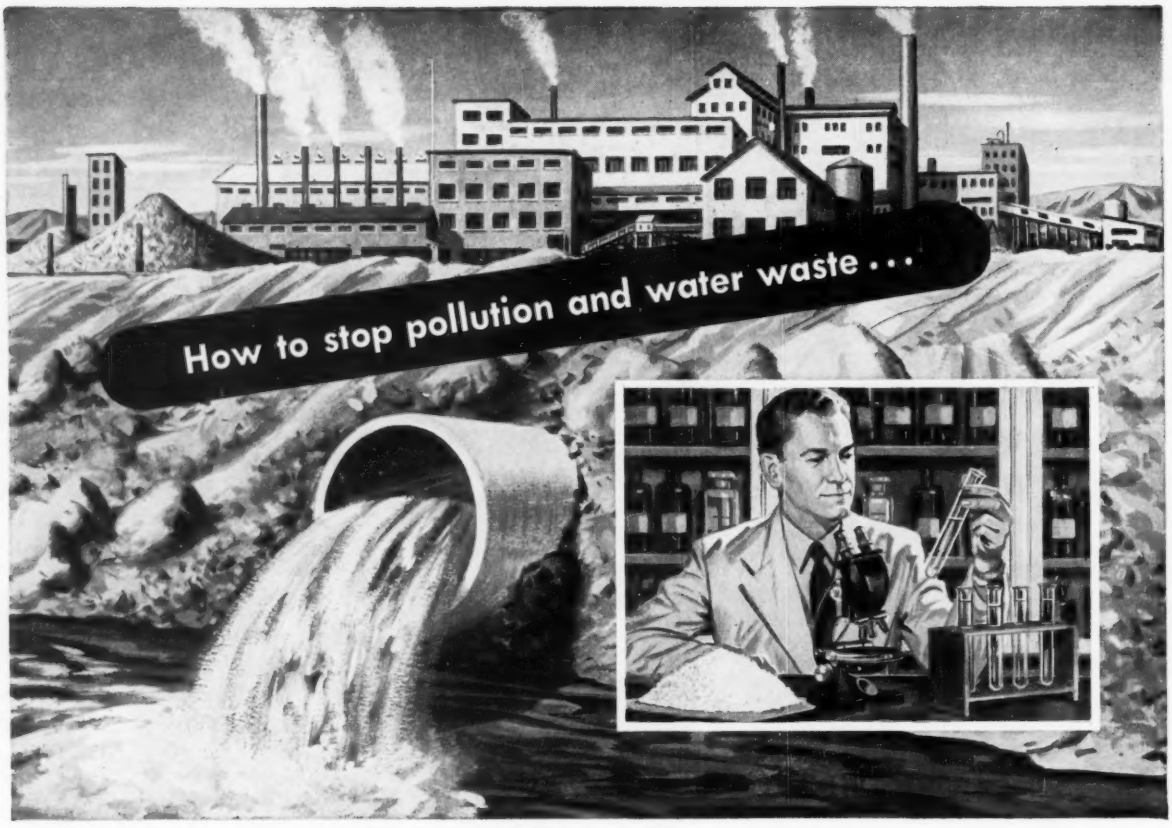
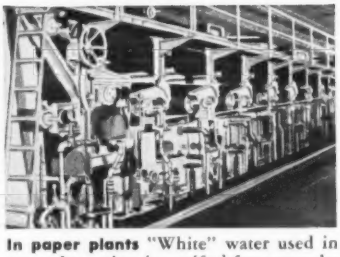
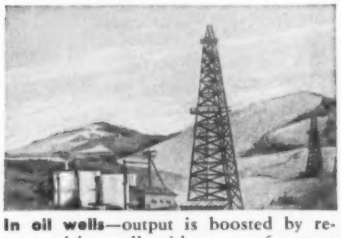
Sales Offices: Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Denver (Englewood), Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.



CELITE FILTRATION removes harmful impurities and purifies water for re-use



In paper plants "White" water used in paper formation is purified for re-use by Celite Filtration. The Celite method can also provide clean pure process water in many other industrial uses—for boiler make-up, heat exchangers, circulating water for towers, etc.



In oil wells—output is boosted by re-pressurizing wells with water to force out accumulated oil. Celite Filtration purifies water to the extreme degree required—removes the minute suspended impurities which would otherwise clog the microscopic pores of sandstone.

CELITE* FILTRATION can reduce your process water costs materially—and it can greatly aid your community's water conservation and anti-pollution programs.

If your plant now discharges industrial water as waste, Celite Filtration enables you to purify this water for *re-use*—at relatively low cost. Celite removes all types of suspended solids. When required, it even filters out fine matter such as amoebae and algae, many of which cannot be removed by other methods. Thus by recycling process water you can save on water costs . . . and save your community's water.

At such times as you still find it necessary to discharge process water, Celite Filtration is an important anti-pollution measure. It helps make water safe and harmless . . . thereby protecting your community's recreational areas, fish and wildlife.

Food processors, beverage manufacturers, swimming pool operators and many industrial users of process water depend on Celite Filtration.

It will pay you to investigate the unique advantages of Celite for your particular application. Celite itself is carefully processed from the purest deposits of diatomaceous earth. It comes in nine standard grades, and you are always assured of utmost uniformity of product. To have a Celite engineer study your problem and offer recommendations, simply write Johns-Manville, Box 14, New York 16, New York. In Canada, 199 Bay Street, Toronto 1, Ontario. *T.M. Reg. U.S. Pat. Off.

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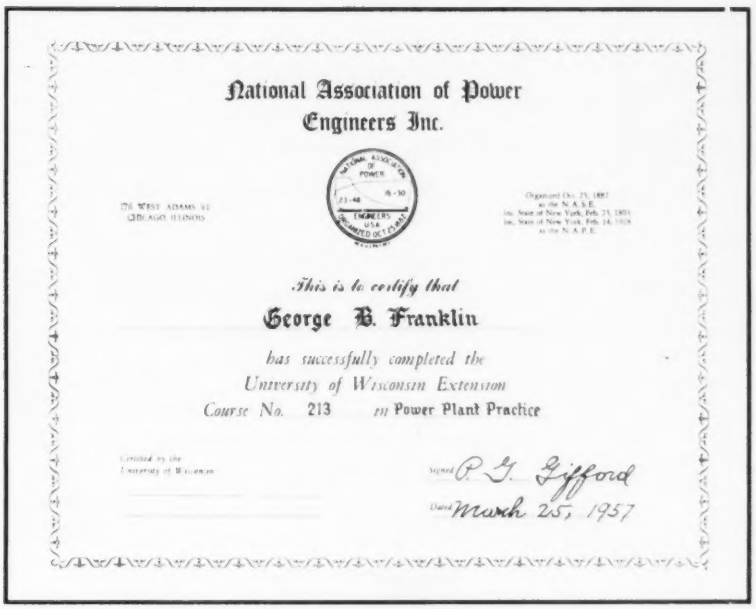
STEVE ELONKA
Associate Editor in Charge



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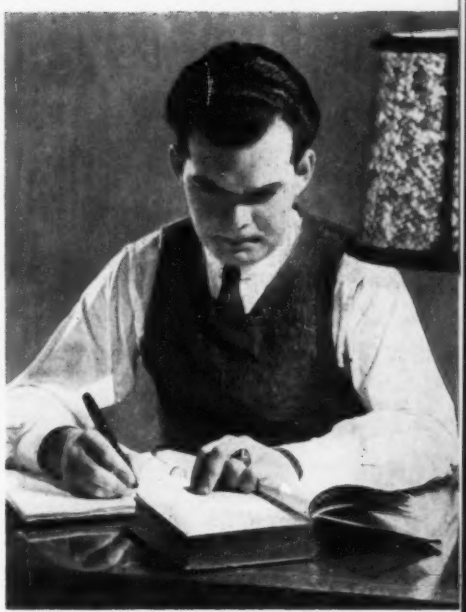
This is to certify that

George B. Franklin

has successfully completed the
University of Wisconsin Extension
Course No. 213 *in* Power Plant Practice

Signed P. G. Gifford
Dated March 25, 1957



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► MODERN BOILERS AND TURBINES certainly don't look like the old-timers. Now, the gas turbine is here and its use is increasing rapidly throughout the country. Nuclear power is no longer a dream. There's no doubt that the power services are pushing ahead rapidly. Can you advance with them?

Most of us can't spare the time to go back to school, but we would like to learn the latest techniques of plant operation. Home-study courses offer a convenient way to further our knowledge in almost any field—and the power field is no exception.

The National Association of Power Engineers offers three home-study courses designed to keep its members up to date with advances in the power services and to help them obtain higher stationary engineers' licenses. University of Wisconsin has prepared the courses. Topics are such that you'll find a course that fits you whether you're a chief engineer or an oiler starting on the way up to chief.

Course 212. *Steam Plant Operation* will give you a working knowledge of the basic principles of stationary engineering. You'll learn approved methods of operating power-plant equipment, and some of the underlying theory. The course is designed for new hands and for operators who want to get a certificate of qualification. But it also is a good review for more advanced work. If your mathematics is rusty, don't worry! There aren't too many problems to solve. The problems and illustrations relate to practical plant experience.

(Turn page)

STEAM PLANT OPERATION

Course 212

1. What is the mud drum and what purpose does it serve?
2. A fuel oil has a specific gravity of 0.87. What is its gravity on the API scale?
3. A traveling-grate stoker 8 ft wide is burning anthracite coal. The grate speed is 3 in. per min and the coal is 4 in. deep. At what rate is coal being consumed in lb per hr?
4. What does the area of an indicator diagram represent?
5. Steam leaving an engine exhausts into a heater. This steam heats the feedwater from 60 to 155 F. The heat content of the steam is 1100 Btu per lb. What saving in fuel would result by this preheating?
6. A steam-plant operator notices that his toaster at home is rated at 1250 watts. He knows that the voltage in his home wiring system is 115 volts. What is the toaster current?
7. What information can you normally find on a motor nameplate?
8. What is meant by admission, cutoff, release, compressi
9. Name three appliances that warn of low water level in a boiler. Explain their operation.
10. A pump 3 by 2 by 3 runs at 75 strokes per minute with a slip of 15 per cent. Calculate the capacity in gallons per 24 hours.
11. What is an impulse turbine? a reaction turbine?

Course 212: STEAM PLANT OPERATION

Text: STEAM PLANT OPERATION, Woodruff and Lammers, 2nd Edition, McGraw-Hill Book Co., Inc., New York, 1950

UNIT	CONTENT
1	Boilers
2	Construction of Boilers
3	Combustion of Fuels
4	Settings, Combustion Equipment, Heat Surfaces
5	Automatic Combustion Equipment
6	Boiler Accessories
7	Operation and Maintenance of Steam Boilers
8	Pumps
9	Reciprocating Steam Engines
10	Valve-Operating Mechanisms
11	Operation and Maintenance of Steam Engines
12	Construction of Steam Turbines and Auxiliaries
13	Operating and Maintaining Turbines and Auxiliaries
14	Auxiliary Steam-Plant Equipment
	Fundamentals of Electricity
	Care and Operation of Electrical Equipment

Course 214: ADVANCED POWER PLANTS

Text: APPLIED ENERGY CONVERSION, Skrotzki and Vopat, 2nd Edition, McGraw-Hill Book Co., Inc., New York

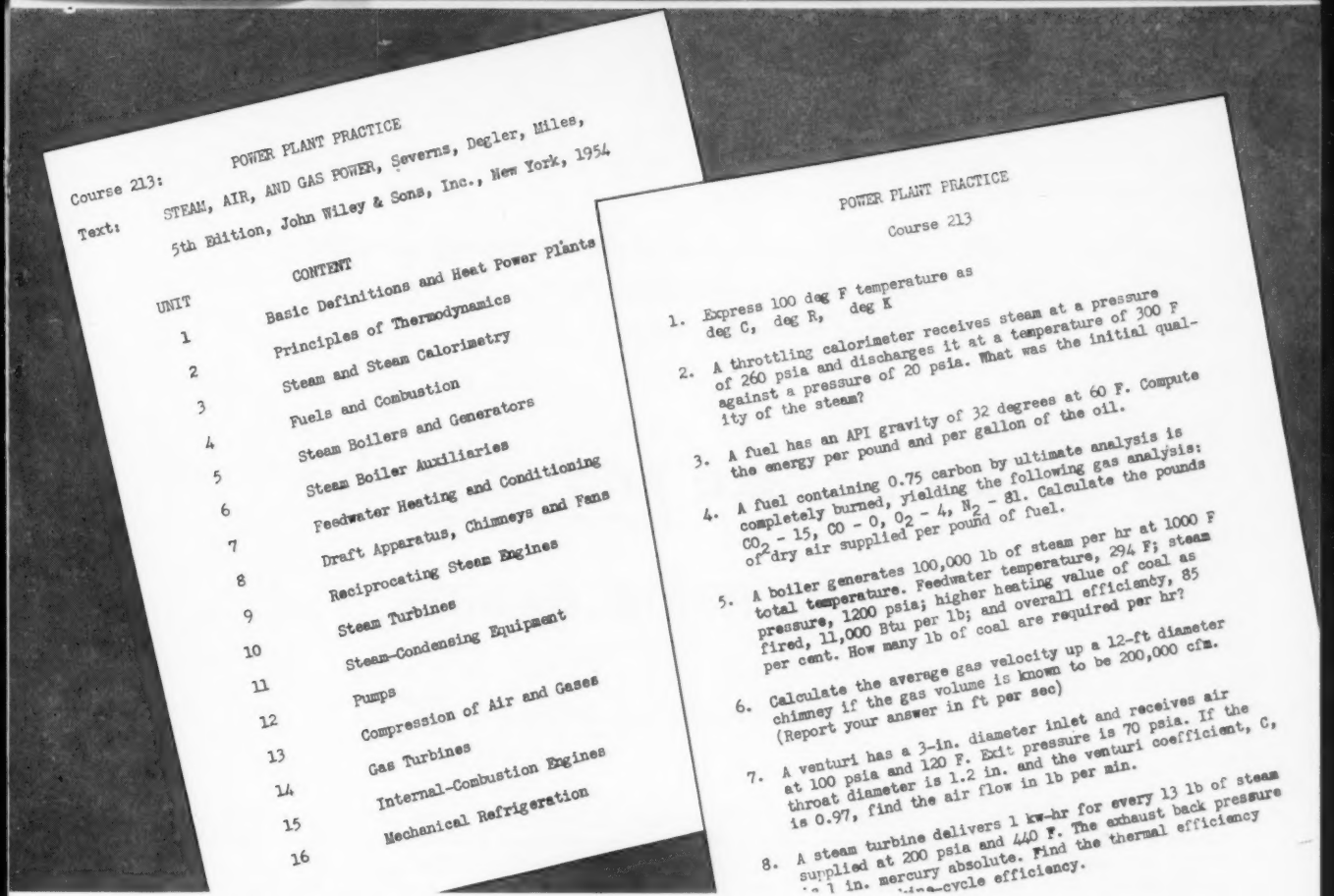
UNIT	CONTENT
1	Raw Energy
2	Steam Power Plant - Combustion Theory and Equipment
3	Steam Power Plant - Steam Generating Units
4	Steam Power Plant - Prime Movers
5	Steam Power Plant - Condensate and Feedwater Systems
6	Steam Power Plant - Application
7	Diesel and Gas Engines
8	Hydraulic Power Plants
9	Power Plant Developments
10	The General Economic Problem
11	Load Curves
12	Selection of Plant
13	Station Performance and Operation Characteristics
14	Specific Economic Energy Problems
15	Energy Rates
16	Atomic Energy

COURSES cover wide variety of subjects to help you keep up with fast moving technology in power field. Over 2000 ambitious members have already rolled up their sleeves for home study. Reason: They want to be promoted to bigger paying jobs

NAPE COURSES continued

Course 213, *Power Plant Practice* will prove helpful to operators and engineers seeking an intermediate certificate. Before tackling this course you should have had a few years' experience in plant operation or something equivalent to it. The basic course stresses the practical side—this one will dig deeper into theory. Assignments and illustrations are based on practical examples. Higher mathematics is held down to a bare minimum.

Course 214, *Advanced Power Plants* should be helpful to anyone interested in developing managerial and consulting skills in power plant practice. Economics of plant location, equipment selection and operation get special attention. Raw energy, combustion theory, prime movers, gas turbines, atomic power, solar energy are a few of the topics covered in this advanced course. You'll need some advanced mathematics, so make sure you're still able to handle algebra, logarithms and trigonometry. This course will be a definite help in meeting the educational qualifications for the highest stationary engineer's license that you will eventually need.



Course 213: POWER PLANT PRACTICE

Text: STEAM, AIR, AND GAS POWER, Severns, Degler, Miles, 5th Edition, John Wiley & Sons, Inc., New York, 1954

CONTENT

UNIT	
1	Basic Definitions and Heat Power Plants
2	Principles of Thermodynamics
3	Steam and Steam Calorimetry
4	Fuels and Combustion
5	Steam Boilers and Generators
6	Steam Boiler Auxiliaries
7	Feedwater Heating and Conditioning
8	Draft Apparatus, Chimneys and Fans
9	Reciprocating Steam Engines
10	Steam Turbines
11	Steam-Condensing Equipment
12	Pumps
13	Compression of Air and Gases
14	Gas Turbines
15	Internal-Combustion Engines
16	Mechanical Refrigeration

POWER PLANT PRACTICE

Course 213

1. Express 100 deg F temperature as deg C, deg R, deg K
2. A throttling calorimeter receives steam at a pressure of 260 psia and discharges it at a temperature of 300 F against a pressure of 20 psia. What was the initial quality of the steam?
3. A fuel has an API gravity of 32 degrees at 60 F. Compute the energy per pound and per gallon of the oil.
4. A fuel containing 0.75 carbon by ultimate analysis is completely burned, yielding the following gas analysis: CO_2 – 15, CO – 0, O_2 – 4, N_2 – 81. Calculate the pounds of dry air supplied per pound of fuel.
5. A boiler generates 100,000 lb of steam per hr at 1000 F total temperature. Feedwater temperature, 294 F; steam pressure, 1200 psia; higher heating value of coal as fired, 11,000 Btu per lb; and overall efficiency, 85 per cent. How many lb of coal are required per hr?
6. Calculate the average gas velocity up a 12-ft diameter chimney if the gas volume is known to be 200,000 cfm. (Report your answer in ft per sec)
7. A venturi has a 3-in. diameter inlet and receives air at 100 psia and 120 F. Exit pressure is 70 psia. If the throat diameter is 1.2 in. and the venturi coefficient, C, is 0.97, find the air flow in lb per min.
8. A steam turbine delivers 1 kw-hr for every 13 lb of steam supplied at 200 psia and 440 F. The exhaust back pressure [illegible] in. mercury absolute. Find the thermal efficiency [illegible]-cycle efficiency.

DON'T YOU THINK these subjects will make you a better engineer? If you're eligible for GI educational benefits, you can save part of costs. Before long, such popular subjects as refrigeration and air conditioning will be added to courses offered

Who's eligible? How much do courses cost? All NAPE members are eligible. If you're not a member, join through the nearest local chapter. Total cost for each course, including text and all materials, is only $35. If you're a veteran, check with the Veterans Administration to see if you qualify for educational benefits. Courses are approved for veterans and you may be able to save yourself part of the cost.

Apply through NAPE National Secretary for the course you want. University of Wisconsin will supply all the needed forms and the course materials. They'll test and grade you at the end of each unit of the course. When all 16 units are completed, you'll be examined in your own or a neighboring town by a University representative. If you average over 70%, the passing grade, you will receive the NAPE Certificate of Engineering.

Weak in fundamentals? If you think you need additional work in mathematics, chemistry or physics before getting into these power-engineering courses, you'll be glad to hear the NAPE has taken care of that, too. Courses are available at both high school and college levels and cost less than $25 each.

Future plans. The Association and the University are working on plans for home-study courses in refrigeration and air conditioning. They'll be ready before long.

To meet the ever-increasing need for trained engineers, the NAPE plans to set up forums in cooperation with local colleges and universities. Each forum will cover a specific technical subject. This plan has been tried by the University of Wisconsin on a small scale. They find it fairly easy to organize classes of 30 to 40 students in a short time.

This educational program aims at reaching all NAPE members—plant trained or college trained. The engineering world is in a process of change, and education of this sort offered by the NAPE appears to be a must if we are to keep pace with changing times.

Further information may be obtained from Mr J D Holmes, Chairman, Educational Committee, NAPE, c/o Magnus Chemical Co, Inc, Garwood, N. J.

National Association of Power Engineers: What it is...

Objectives. Preference is given to engineering education. Its members pledge themselves to the securing and enforcing of engineers' license laws. *Reason:* To prevent destruction of life and property in the generation and transmission of power. Also for the conservation of the nation's fuel resources. This is accomplished by turning out better operating engineers.

History. Founded in New York in 1882, as the National Association of Stationary Engineers. They publish *The National Engineer*, a monthly magazine that goes to all members. Present name was adopted in 1928, although magazine began in 1897.

Membership. Today there are about 180 chapters with total membership of 15,000. To be eligible for membership you must be engaged in power plant operation, or a closely allied field, or you must have an engineering degree.

Passing the written exam is generally the biggest stumbling block for the would-be professional engineer. But, with careful preparation, it needn't be. Here's . . .

How to take and pass the PE licensing exams

By JOHN CONSTANCE, *Professional Engineer*

► IF YOU HAVE THE EXPERIENCE and professional know-how, your state registration board *wants* you to have a PE license. It isn't their job to throw roadblocks in your way. Actually, the opposite is true. Boards want to advance recognition of professional engineering by awarding licenses to the greatest possible number of qualified engineers.

Yet, your board's first responsibility is to the public—to keep unqualified men from assuming responsibility for the design and construction of projects that involve health, life, and safety. And it relies, in part, on the written exam to do the job.

In POWER, July 1956, pp 107-109, we talked about the advantages of getting your license, what the general requirements are in most states. Now, let's concentrate on the written exam itself.

Generally the exam is the biggest stumbling block for the would-be PE. But it doesn't have to be. Younger men seem to find the exams easier than older, more mature candidates. And the state boards appreciate this. They are presently studying ways of giving a different type of exam to the older group. While the new test wouldn't be easier, it would give the older man an opportunity to show his ability to exercise mature engineering judgment.

OBJECTIVES OF THE EXAM

Here's what your state board wants to know when you sit for the exam: (1) Whether or not you understand basic engineering principles. (2) If your training and experience have taught you how to apply these principles to practical engineering problems.

Naturally, the test can't cover every detail of your engineering know-how. So it's largely a sampling process. Exam writers carefully work out a broad distribution of problems. Thus, if you've prepared, you're likely to find enough questions that are right up your alley.

Common practice among states is to divide the written test into four parts, each four hours long, spread over two days. One day covers basics. Second day hits on applications. Some states get good coverage in three 4-hr exams.

First day's exam. Practically all boards conform to the first day's questions as founded by The National Council of State Boards of Engineering Examiners (NCSBEE). Although engineering college courses differ in some details, there is a core of common material. Diagram, facing page, lists material covered during first day.

In addition, many schools include ethics and business law or contracts. These important subjects are finding their way into the exams, especially in that portion given after you've had the required practical experience.

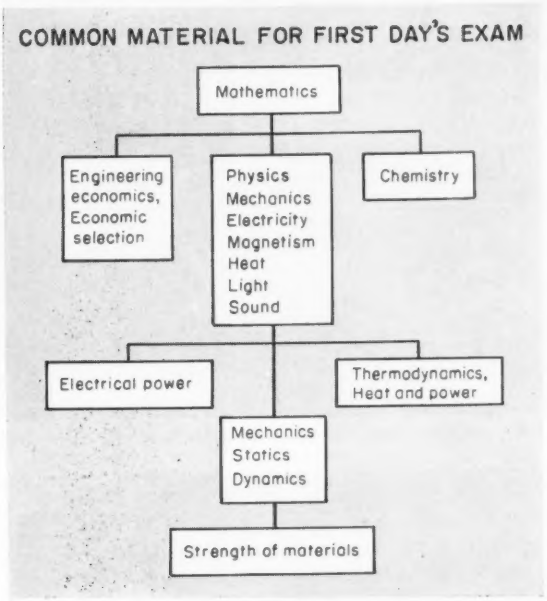
A glance at the diagram points up the basic importance of math. Understanding the physical sciences (statics, dynamics, fluid mechanics, thermodynamics, electricity) depends on a solid foundation of mathematics. Examiners, recognizing the importance of this tool, commonly ask for mathematical solutions of physical problems.

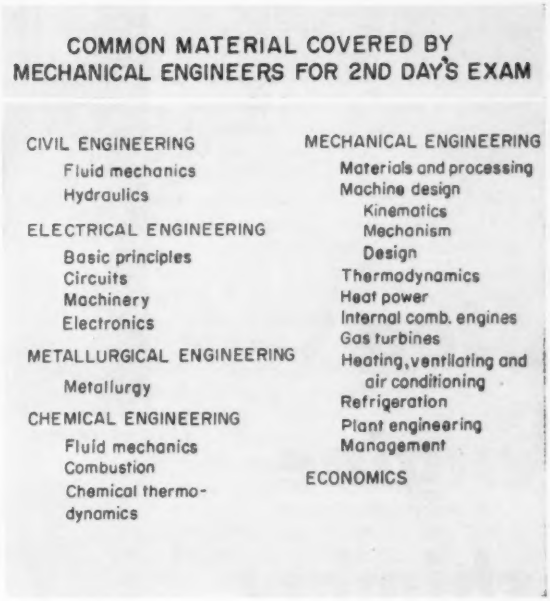
Second day's questions. Having established your ability in math and engineering theory, the second day's questions are frequently essay type. Or, they may call for a detailed description of a project with which you've had experience. Their intent is to have you exercise your judgment in economics as well as practical engineering. And testers word questions so that you need practical experience to understand them. *Example:* Discuss briefly, but clearly, the unique characteristics of cyclone-furnace fired steam-generating units from the viewpoint of equipment or of the features listed below:

(a) Quality of fuel permissible
(b) Forced- and/or induced-draft equipment
(c) Special air-heater design provisions
(d) Operation at low loads

Time to answer. Boards aren't interested in asking questions that call for extremely long answers. Usually, a question is supposed to take 30 to 45 minutes. Some should take even less time. Most examiners give equal weight to all questions, thus discouraging long answers. *Result:* The more mature candidate chooses his words carefully.

Exam practices. Some state boards use the open-book test; others use closed book. Open book measures your ability to recognize and correctly apply engineering principles. Also, some examiners include a limited number of closed-





book questions, especially when such questions include definitions that could easily be copied from a book.

PREPARING FOR THE EXAM

An early start is important. Your state board's secretary (See POWER, July 1956, p 109, for list of state board secretaries) can tell you where to get info on enrolling in refresher courses. He'll also tell you where to get copies of past exams. If you've had many years of experience, it may pay to check the possibility of getting a waiver of a portion of the written exam. Success in getting a waiver depends, in part, on how carefully you prepare your experience record.

If attending a refresher course is inconvenient, you should look into refresher courses for home study. Avoid "cook book" style preparation. If you simply work out problems without getting a good understanding of fundamentals, you're likely to trap yourself into a feeling of hollow security.

Look over past exams and you'll see that the core of the material they cover remains pretty much the same from year to year. But the boards leave the "cook book" engineer high and dry by giving the newer exam problems a different slant. So there's no substitute for careful preparation.

Examiners bar text books from closed-book exams. For open-book tests you'll be allowed to use reference books, text books, personal notebooks and any other material that may help you. Texts that you've used in college or in other courses are a first-rate source of info. Also, compilations of past exams can reveal much useful data. Past exams will familiarize you with problem wording, technical areas the board generally covers. Most important, they'll build up your confidence.

SITTING FOR THE EXAM

Besides knowing your field of engineering "cold," you should master the art of taking the PE exam. Here are some pointers:

- Get a good night's rest before the exam
- Get to the exam room early. And don't rush
- Sit in a well-lighted area of the room
- Be sure to read all directions carefully
- Write neatly—usually in ink
- Write on one side of the paper only
- Write no more than one solution on any one sheet
- Draw a diagram to help explain each solution
- Do the easiest problems first. It'll build confidence
- Allow yourself equal time for each problem
- Don't linger over problems you can't answer

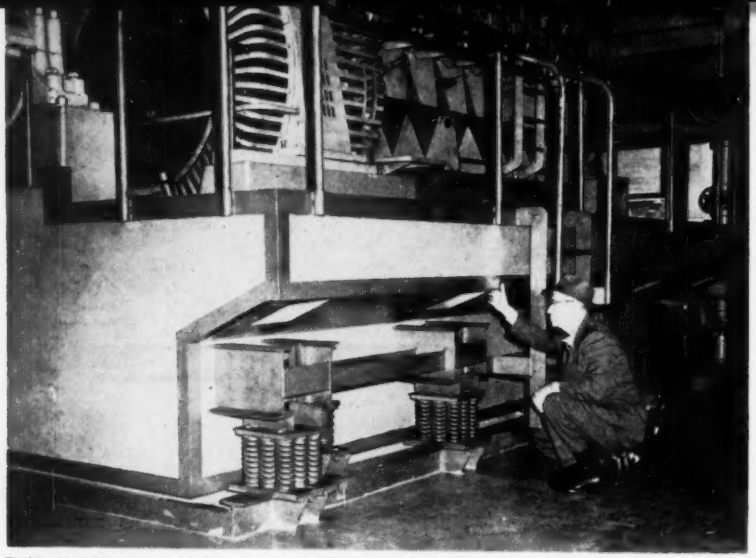
Read through the entire exam before attempting to answer any of the questions. As you read, check the problems with which you are most familiar. This first reading will take you no more than 10 to 15 minutes. And it's time well spent. Then divide your time equally among the problems you choose to answer. When the time you've allotted to a problem runs out, go on to the next one—even if you're not finished. *Remember:* Examiners give you a large part of the credit for simply setting up the problem and showing an understanding of what's wanted. So it's not smart to spend a lot of time trying to get refined numerical answers at the expense of completely ignoring another problem that you could answer with relative ease.

By taking the easiest problems first you'll build up confidence, ease off tension.

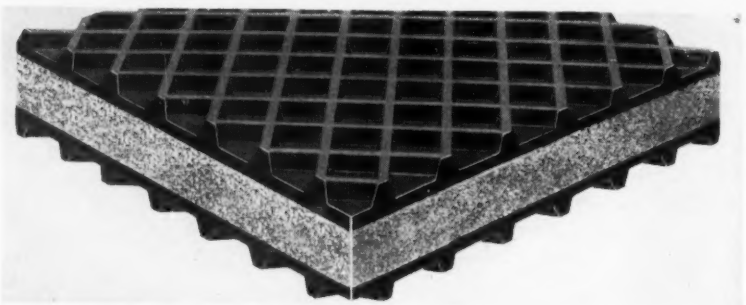
Common complaint of candidates: "I couldn't remember the simplest formula in the exam room. But now that it's over I could wade through those problems with flying colors." This candidate was prepared, but he couldn't respond. Why? He suffered an emotional block. You can avoid this pitfall by simply relaxing. If you feel tension mounting during the exam, ask permission to leave your desk for a break. But remember: The best defense against emotional block is careful preparation.

What to take into the exam. You'll get detailed instructions from your state board on this score. They'll generally require some form of identification or admission card. In addition, these items will come in handy: (1) wrist watch (2) fountan pen and ink (3) pencils (4) slide rule (5) log tables (6) cross-section paper (7) scratch paper (8) ruler, scale, triangles (9) protractor (10) reference books if they are permitted.

Stop engine shimmy



THIS ENGINE on building's upper floor has spring-isolated concrete foundation



RUBBER-CORK MOUNTING is used mostly under high-speed engines and machinery

By **DONALD H VANCE**, *The Korfund Co, Inc.*

► VIBRATING MACHINERY is costly. Here are five reasons why you should mount it properly in the first place:

1. You can install engines anywhere if you prevent vibration and structural-borne noise transmission. That means in industrial, apartment or institutional buildings.

2. You can often eliminate special foundations and you may not have to reinforce floors. Most high speed, and some slow speed, engine-driven equipment can be mounted directly on vibration isolators without any foundation. These include upper floor and mobile units.

3. Cuts down original building and foundation costs. Besides not needing foundations, isolators often eliminate need for piling in poor soil. Light concrete mat under the isolators spreads the equipment's dead weight over a large soil area. Isolators also prevent transmission of vibrating forces that would cause foundations to settle.

4. Reduces maintenance costs. Many solidly mounted engines, especially engine-compressor units, almost tear themselves and their foundations apart. Stresses from this unbalance can cause bearings to wear, foundation bolts to break, and concrete to crack. In contrast, a resiliently-mounted engine or a resiliently-mounted engine foundation moves very slightly. This slight movement dissipates the forces or couples without damage to equipment and foundation, prevents stresses and strains.

5. Protects engines against external shock and vibration, especially in mobile installations aboard ships, trucks or railroads. On such jobs the resilient mountings also prevent engine from twisting as the sub-base deforms from rough seas, roads or tracks. All this is extremely important.

Selecting vibration control. Here are five factors:

1. Engine characteristics: number of cylinders, cylinder and crank arrangement, and engine rpm determine unbalanced characteristics that cause vibration. You can mount most high-speed engines (over 900 rpm) of the 1, 2, 3, 4, 6, and 8 cylinder types directly on isolation mountings without a concrete foundation. This holds if driven equipment is close coupled to the engine or mounted on a structural steel base with the engine. But unbalance in the 1, 2, 3, and 4 cylinder engines will cause equipment to move, so all piping and wiring should be flexible.

Large, slow-speed engines usually need concrete foundations for two reasons: (a) To assure rigid connection between engine and driven equipment. This engine is seldom close coupled to equipment. It usually isn't factory mounted on a structural steel base as is a high-speed engine. (b) To reduce amplitude of movement caused by forces and couples in large machines. Base foundation-size calculations on unbalance data. Size varies from a weight equal to engine's weight up to six times engine's weight, depending on unbalance.

2. Characteristics of driven equipment: If your engine is driving a generator, the major unbalance affecting the system is from the engine. But other types of driven equipment, such as pumps and compressors, may have unbalance characteristics that influence the system. *Example:* An engine-pump unit often generates vibration at pump rpm as well as at pump rpm times number of impellers. The

great unbalance in engines driving horizontal compressor cylinders is mostly from the compressor. Always consult equipment manufacturer's data on unbalance. It will help you decide how and where to install such equipment.

3. Type of soil, especially for engines on ground or basement elevation. Soil characteristics are important. *Example:* Large gas-engine compressors used in the Gulf Coast area generate vibration at almost exactly the same frequency as soil frequency. This causes excessive foundation movement, transmits vibration. If your engine is known to generate disturbances at frequencies close to soil frequency, you must control vibration. If not, the engine's unbalance will excite the soil, as following table shows.

Typical soil frequencies

Type of soil	*Cycles per second*
Peat	7.5-12.5
Waterlogged estuarine silt	10
Sand, wet	15-23
Sand, dry	17-30
Clay, wet	18-22
Clay, dry	19-29
Gravel	30
Limestone	30
Sandstone	34
Granite	40

4. Type of substructure under engine. Engine on an upper floor, or any type of mobile installation, has a much less rigid support than engines on a ground floor or large foundation. Therefore, more efficient isolation is needed for such installations. Here isolators usually pay for themselves quickly by making such installations possible.

5. Proximity of the areas affected by vibration or noise transmission. Engine pumping unit on pipeline duty in the middle of an open field doesn't need vibration isolation to prevent annoyance to neighbors, but isolation here might be justified for other reasons given before. But a similar unit in a congested area does need isolation. Machinery in apartments, hospitals, radio stations and similar locations must be vibration- and noise-free. Consider these factors to decide if installation is critical or noncritical when you select a type of isolation.

Type of vibration control. Three most widely used materials are steel springs, rubber and cork. While first cost is greater, steel springs are by far the most efficient. Steel springs have longest life, are needed in critical installations.

Where structural-borne noise transmission is a problem, place rubber pads under spring isolators. Pads stop high-frequency noise transmission. Rubber mountings are used mostly on smaller, high-speed engine generators, and they often do good job. However, some of these very critical installations do need springs. Rubber mountings tend to harden with age. Their useful life is from 7 to 10 years. Take special care when using rubber at below – 50 F or above 140 F. Also take care when rubber is used in the presence of oil.

Cork is generally used under concrete foundations. It's an excellent noise isolator but isolates only high-frequency vibration. So use with great caution to avoid resonance with higher order harmonics of engine vibration.

There's a very definite analytical theory covering selection of proper type isolation material. It depends on disturbing frequency generated by engine. You can obtain the theory from references at end of this article. If job conditions seem to justify isolation, it's most important that you consult a competent, thoroughly experienced manufacturer of vibraton-control products for best results.

They know engine characteristics and location, and can select right type of mounting for your equipment and job conditions. They will assure you a good installation at lowest cost. Disregard of the vibration control theory and installation of the wrong materials has cost many companies plenty of grief and thousands of wasted dollars.

Common pitfalls. I've seen many cases of massive concrete foundations tried for effective vibration control. This isn't a safe solution if transmitted vibration is your problem. *Reason:* Such foundations still move slightly. They send out pulse waves through soil contacting the foundation. Sometimes there's objectionable transmission a mile away. This is especially true of rocky, clayey or spongy wet soils (since water is an excellent vibration conductor). To cut the floor out for about 2-in. around engine's perimeter foundation is no sure solution. Here the vibration goes through the soil to building columns, then spreads up into building.

Some people have tried to use sand as a vibration isolator. But theory and practice both prove that an efficient isolator must have resiliency. There's no resiliency in sand. It packs into a hard mass under the engine's foundation.

Vibration control materials can stop all transmission of vibration and structural-borne noise to the building and to adjacent buildings. But you must provide flexibility in the fuel and exhaust lines, or vibration will be transmitted from these lines into the building. One common practice is to suspend the heavy exhaust lines on spring hangers to prevent transmission. Where air-borne noise is the problem, there's no substitute for muffling the system efficiently.

Compared to total cost of engine and installation, expense of proper vibration control is almost negligible. It's inexpensive insurance against serious problems. In other words, do the job right the first time and you won't have to worry about vibration- and noise-free engine operation.

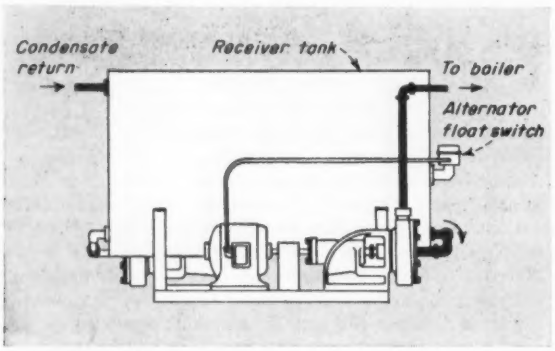
For more information, read: (1) Rosenzweig, S, *Theory, Application and Benefits of Engine Vibration Isolation*, Eleventh National Oil and Gas Power Meeting, ASME. (2) Vance, D H & Booth, R L, *Vibration Control and Noise Silencing* section of *Plant Engineer's Handbook*, McGraw-Hill Book Company, New York, 1950. (3) Wilson, W K, *Balancing of Oil Engines*, J B Lippincott Co, Philadelphia.

"Now repeat after me, . . . I will not try to oil machinery through a rotating flywheel."

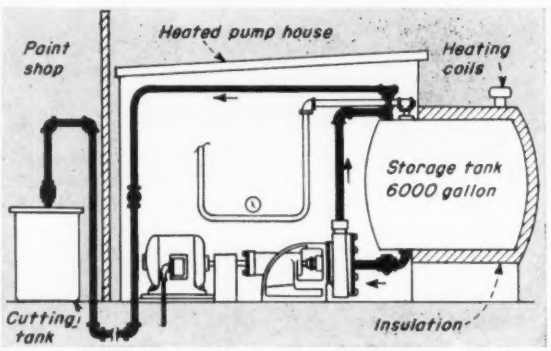
OPERATORS' NOTEBOOK 105

End-suction centrifugal

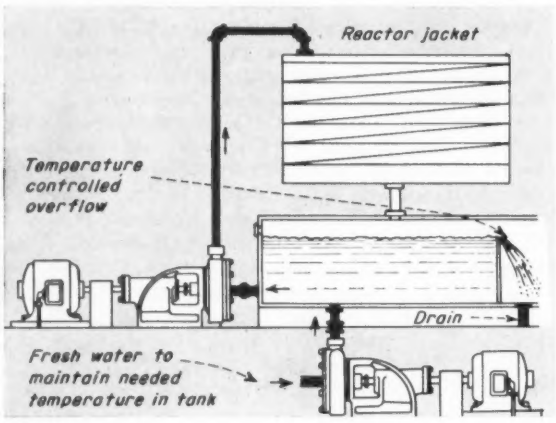
Some handy pump applications



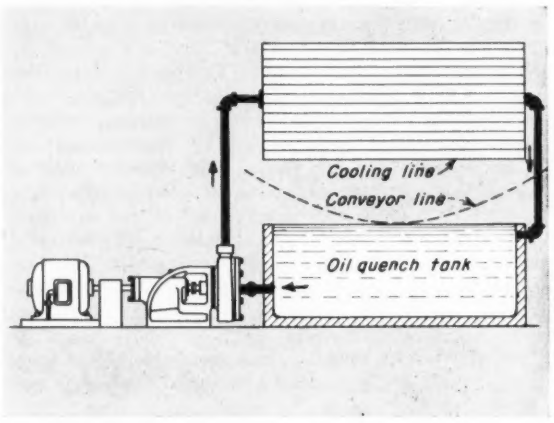
DUPLEX CONDENSATE UNIT has an extra pump for occasional heavy demands; reliability. Condensate returns to boiler from the steam coils, radiators or steam-operated equipment



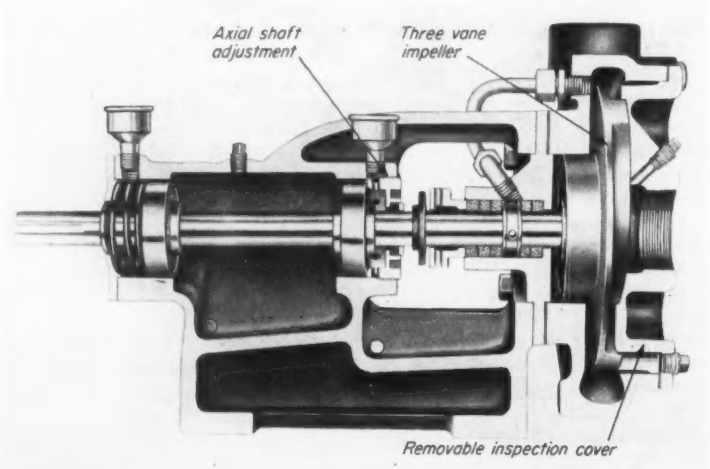
PAINT STORAGE TANK is outside the plant's many buildings. Paint is pumped as far as a mile to various buildings. Temperature is maintained at the right level for easy mixing



REACTOR JACKET needs continuous cooling to a constant temperature. Water is conserved by returning it to supply tank. Self-acting temperature-flow valve maintains temperature



QUENCHING BATH must be agitated to keep its temperature uniform in all parts of tank. At same time, oil is recirculated at constant temperature for each piece of metal quenched



What you should know

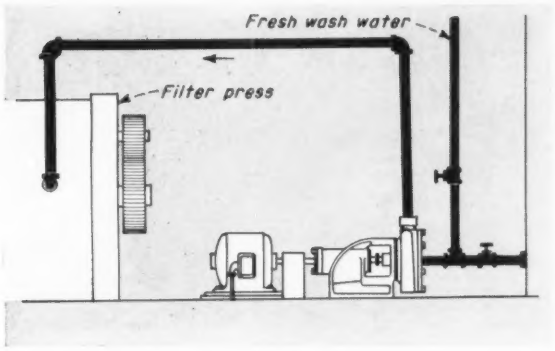
► END-SUCTION centrifugal pumps are reliable old workhorses of industry. As name implies, fluid is drawn into end or "eye" of pump at impeller's center, then forced out at impeller's rim.

Semi-open, three-vane, nonclogging type impeller shown has only one sidewall. Being semi-open, it allows dirty water and many kinds of foreign materials to pass through impeller vanes.

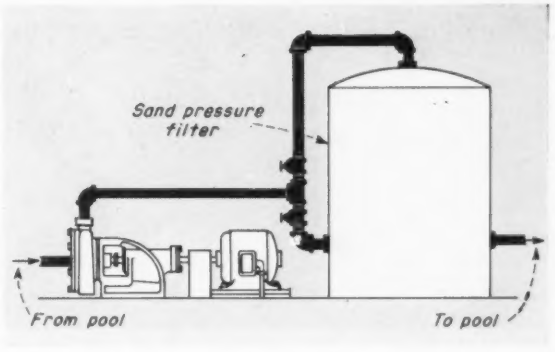
You can adjust running clearance between open side of impeller and cas-

pumps do many tough jobs

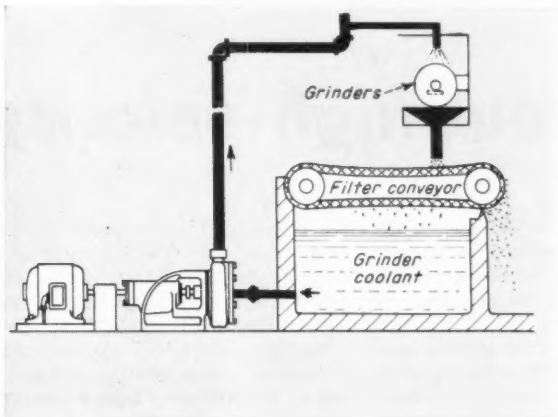
By **STEVE ELONKA**, *Associate Editor*



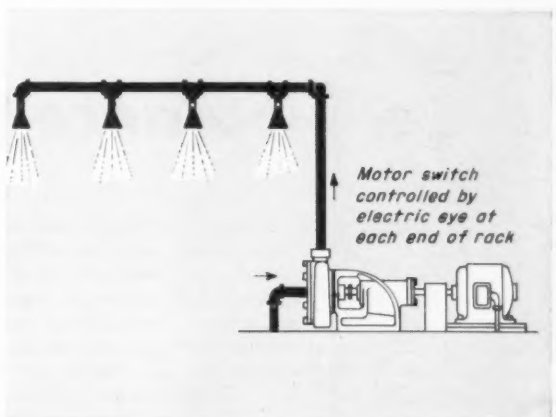
ACID-RESISTANT PUMP transfers slurry to a press where the liquid is removed. Then the pigment is dried and prepared for making ink. This is one of the many process applications



SAND FILTERS are serviced by 5-hp pump that recirculates 122,000 gallons of water through filters in about 8 hours. It also backwashes each filter at rate of 330 gallons per minute



METAL-CUTTING OPERATIONS bring up several problems. Fluid is expensive and must be saved. Hookup, shown, conserves the cutting fluid for filtering and also for immediate reuse



LIMESTONE SCREENINGS carried by truck must be wet down. Electric eye at spray track's end operates pump. Truck is rinsed and limestone wet down without the driver dismounting

about this type of pump

ing while pump is running. Move shaft axially with screw, drawing, lower left, p 116, then lock it in place. Axial movement also affects pump's capacity and head, reduces impeller wear.

Suction cover can be removed to inspect the impeller. Some impellers have wiping vanes on back. You need these vanes for handling liquids with lime, chips and solids that tend to coat metal surfaces or clog space between casing and impeller. These conditions cause needless wear and also eat up costly power.

Another advantage of these pumps is that liquid end can be supplied in various metals without changing the power end. Where standard cast-iron pumps can't be used, liquid-end parts may be of special alloys, while the support head can remain cast iron. These features can save money.

Pumps shown, range from 1- to 5-in. discharge size with capacities up to 1000 gpm at 250-ft head. Either standard packing or mechanical seals are used, depending on service. Flushing-type stuffing box can be used for shaft cooling or high-vacuum sealing on pumps operating at 200 F or over. Some of the many uses are shown. Pumps are designed so when pumping liquids of viscosities and specific gravities not greater than water, motors won't load above 10% of their standard hp ratings. *Courtesy, The Deming Co, Salem, Ohio*

Balancing high-velocity air conditioning is an art. But newer techniques are giving it all the earmarks of a science, says Bill Waeldner of the Anemostat Corp of America

Let's balance your high-velocity

► TODAY'S TECHNIQUES for balancing involve trial and error. They come closer to being called an art than a science. But our experience with high-velocity systems and the bugs that sometimes develop in them, shows that we can bring a measure of science into the art.

We'll start with some basic pointers, then go into actual balancing procedures. First, make certain the air-conditioning system is complete. Be sure all high-velocity components, diffusers and controls are in operating order.

Next, go over the entire system. See that it meets specifications. Note the capacity of each unit as well as total fan capacity. At this stage you should also anticipate any special balancing requirements due to minimum flow limitations for manual- or automatic-volume controlled units.

Balancing tools you'll need are: (1) draft gage and tubing, preferably a dry-type gage (2) capacity calibration curves, Fig. 1, for each unit in the system (3) screwdriver or speed wrench (4) meter to accurately measure air velocity. Electronic-type velocity meters are commercially available.

Before you start to balance, adjust valves of all high-velocity units to a fixed position at the middle of the capacity-static pressure range. Equipment manufacturer usually does this before he ships the unit. Thus the capacity handled by all the installed units is roughly equal to the final-balance total capacity, providing you've properly adjusted the fan and other system components.

Balancing procedures. You've now waded through the preliminaries. Let's begin actual balancing. But remember: Steps we list below are a basic guide—your particular installation may call for a modified procedure.

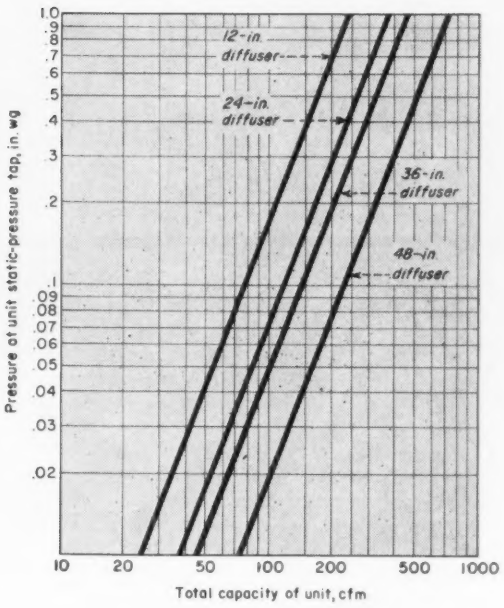
Start by checking total capacity of your central air-handling unit. It should come pretty close to design capacity. If it doesn't, adjust the inlet-vane damper. Your plant may require adjustment of the fan-discharge damper or the fan drive. We've found that inlet-vane or vortex dampers work best on all high-velocity systems. They're considerably easier to adjust.

After adjusting total capacity to the design figure, set a typical unit close to the fan and also one near the end of the duct run. If you've picked typical units, chances are you'll have to open the valve on the unit at the end of the duct run and partly close the valve on the unit near the fan.

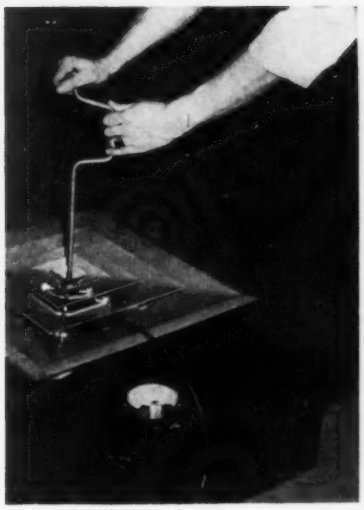
On high-velocity duct systems, only a minimum pressure should exist at the end of the duct run. Excess pressure here boosts pressure throughout the entire system. *Result:* high noise levels. Noise can climb as much as three decibels if static pressure goes from a minimum to 3-in. wg.

On large systems with several long, parallel branches, check the units at the extremes of each branch before adjusting all the units on any one branch. After setting end-of-the-run units to their correct capacity, balance the remaining ones, starting close to the fan and working toward the end of the duct run. *Caution:* Be sure to use the correct calibration curve. As a final test, make spot checks along the system after you've completely balanced it.

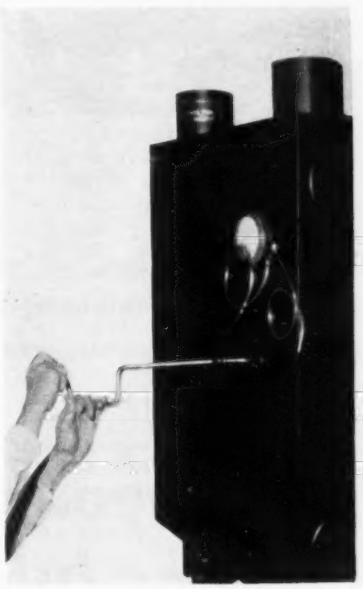
Automatic-volume control. You balance single-duct systems with automatic-volume control in essentially the same way as described above. But before checking total system capacity at the



1 Calibration curve for a straightline or under-the-window unit, relates capacity to the pressure drop



2 Balancing a ceiling diffuser. Gage connects to the static-pressure tap



3 Octopus-type unit requires two taps for measurement of its pressure drop

air conditioning

central air-handling unit, set the static-pressure control dampers in a fixed position and adjust the pneumatic-damper operators to open the unit valves. Here's how: Either bleed the pneumatic control line to all the room thermostats or adjust the individual room stats so valves will open full. Then you can balance the system in the same way as above, for a single-duct manual-control system.

After you've finished balancing, adjust static-pressure controls to hold a constant duct pressure, regardless of total air capacity handled. The controls may consist of a vortex damper with the static-pressure sensing element about midway down the duct run. On large systems each branch may have its own static-pressure damper. In either case, measure duct static pressure at the sensing element of each damper. And calibrate the damper to hold this pressure. Once system is in balance, with static-pressure dampers adjusted, return the individual room thermostats to their control position.

Dual-duct systems. We balance dual-duct systems in much the same way as single-manual or single-automatic systems. But we add several steps to take care of the second duct. In the steps that follow we've assumed cold duct can handle the total volume of supply air and the hot duct can handle any probable percentage of the total—say between 25 and 100%, as conditions warrant.

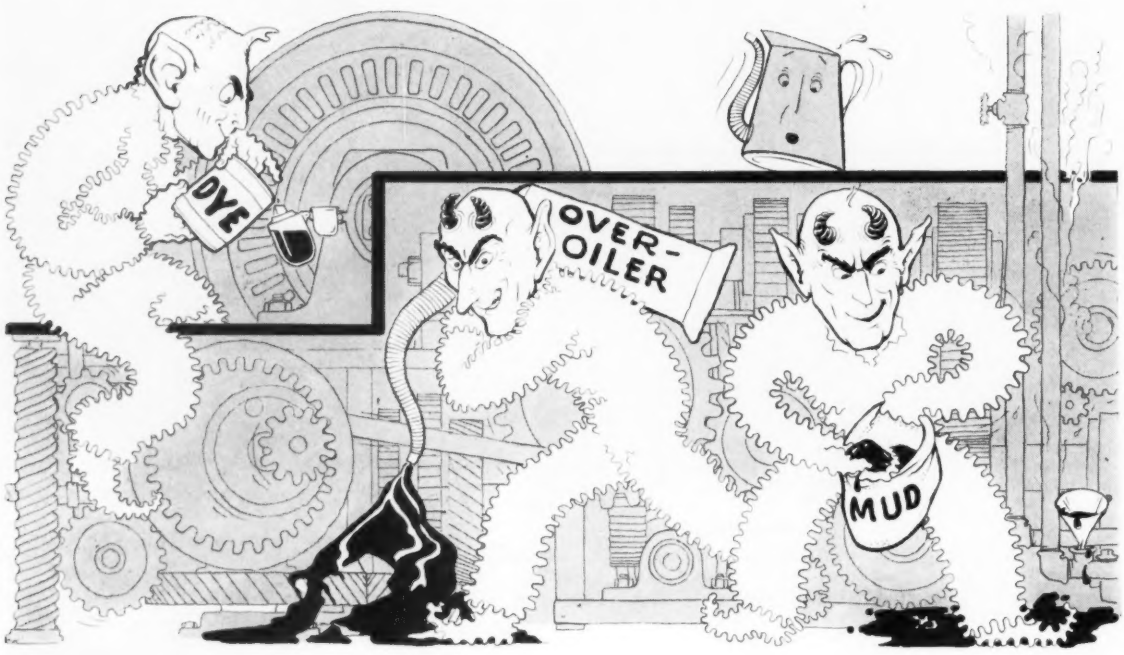
Open all high-pressure unit dampers to the cold duct. Since duct static-pressure drop is greatest at maximum air capacity, balancing must be done with full flow through the cold duct.

Disconnect the automatic-volume or static-pressure control (because its calibration point isn't known until system is in balance). If you use automatic-volume control, adjust it manually to set total system capacity. You can make the same adjustment even if your system has an automatic static damper. If this gives you a partly closed static-damper position, install a mechanical stop on the damper to limit its maximum open position. Our experience with dual-duct systems shows that volume-type control at a common point in the air-conditioning system provides better control than single static-pressure control at each air-handling duct.

After adjusting total volume, balancing follows the same procedure as for the single-duct manual-control system we outlined above.

Next, we calibrate the automatic-system controls to hold conditions set up during balancing. For static-pressure controls, dampers on the hot ducts are calibrated to the same pressure as on the cold (*Continued on page* 212)

LUBRICATION FIELD NOTES: 3



Overheated bearings, oil color change and dripping oil plagued three electric-motor owners. Here's what a lubrication engineer found on investigating the circumstances:

Extraneous conditions often pose as lubrication problems

By **SIM JESTER**, *Gulf Oil Corporation*

► WHEN CALLED OUT on a lubrication trouble-shooting job, my first problem is to find the real difficulty. It is often masked, and the symptoms look like an ailment quite different from the actual disease. For instance, take the three situations below:

Overheated bearings. A steel mill complained of overheated bearings on a large motor generator. This unit furnished power to drive a 1200-hp two-high reversing blooming mill. The mill had been in service for some time and temperature of the ring-oiled m-g bearings usually ran around 110 to 120 F. The bearing reservoirs had recently been cleaned, flushed and refilled with a high-quality turbine oil. The men saw that coincident with this oil change, bearing temperature rose to 140 F. This temperature was not excessive, but since bearing had previously run under 120 F, regardless of load, plant men claimed the new oil was the culprit that raised the temperature.

They insisted that we send a bearing-oil sample to the laboratory for analy-

sis. Report showed the oil was up to par. This proved our oil was not at fault—but it provided no clue as to the cause of the trouble.

There were no cooling coils in the bearing, so operators could not counteract the temperature rise. The electrical windings were air cooled. But examination showed very little temperature drop through the air cooler which used circulating water from a nearby lake as the heat-exchange medium. It so happened that recent rains had made the lake very muddy. At my suggestion the men looked in cooler's waterside—it was half filled with fine mud.

Now we had the real cause of the temperature increase: Cooling-air temperature probably rose 30 F and no doubt room temperature increased slightly. Since less heat was being removed from the windings, more heat was conducted out the shafts to the bearings. This caused the mysterious high-bearing temperature. It all made sense when we found the cause of the trouble and removed the blame from the oil.

Oil color change. In another case, a paper-mill maintenance superintendent became alarmed when he learned that a premium-quality oil turned purple in some motor-generator bearings. His concern was justified since these m-g sets supplied power to drive the various sections of a huge paper machine. He was sure something was wrong with our oil, and suggested the possibility of an electrolytic reaction with one of the oil additives.

The generator room was small and had a low ceiling. Light wasn't too good and the turbine-generator gave off a lot of heat. Of several m-g bearings in the room, only two seemed to contain the dark oil. You could see it in the transparent plastic bottles of the constant-level oilers.

I examined the oil with my flashlight —most of the color disappeared. Here's what had happened. A couple of the bottles were in shadows and optical illusions made the oil look purple. In addition, heat had aged some of the plastic which made the oil look darker. A few bottles had been replaced, and in them the oil looked OK.

I lifted off the plastic bottles containing the "purple" oil and let it run out on my hand. This convinced the superintendent that the oil was all right and that they had been fooled by extraneous conditions.

In practice, plastic bottles are frequently preferred because they don't break easily. But here the plastic may have been of inferior quality.

Dripping oil. Another oil-lubricated motor problem came up in a large sugar refinery. Management wanted an oil that wouldn't drip from the motor bearings. Of course there are several "dripless" oils available, but they all contain a thickening agent that retards natural circulation and usually depreciates the long-life stability of a well-refined straight mineral oil.

Offering a heavier lubricant to eliminate leakage would only sidestep the issue and reduce lubrication effectiveness. So I asked to see the motors before making a recommendation.

The "leakers" were in the finishing department, where large, horizontal drum-type granulators ground sugar crystals to the proper fineness. Everything was painted white and kept spotless. Biggest problem was to keep the floor clean under the electric motors.

There was a big spot under each motor bearing. Stains were especially bad under the more accessible bearings and oil leaked from practically every ring-oiled motor in the department. The superintendent believed that the type of oil used caused this. Plant personnel were concerned about cleanliness. To me the potential fire hazard appeared far more serious.

The oiler claimed he used the same oil supplied for plant's other motors. There was so much leakage he had to refill the sight cups twice a week.

I became suspicious and checked the level in the elbow sight cups on each bearing. They were all full, up to the top—with the motor running. And what happened when motors were shut down? Extra oil in the bearing and on the rings drained into the reservoir, raised oil level and flooded over the sight cups.

Several cups had missing spring caps. But even with caps they couldn't have withstood the head of oil. When motor was started, level dropped as bearings picked up oil. Our over-eager oiler filled the cups again, repeating the leakage cycle.

The verdict was not to change lubricants but to instruct the oiler to change his methods. I explained that oil level of ring-oiled motors should be checked when the motor is stopped.

Such motors need very little makeup. Constant-level oilers at each bearing would eliminate the need for frequent attention and provide a visible supply of makeup oil to last several months. This type of device also keeps dust and dirt out of the bearings.

In this plant, sugar dust created problems when mixed with oil or grease. I convinced them the problem was caused by over-zealous lubrication, not by the type of oil used.

Falls hurt—be alert

► In conjunction with its nationwide campaign to reduce accidental falls, the National Safety Council points out:

1. Falls account for more accidental deaths and injuries than any other cause, with the exception of traffic accidents.
2. Falls take a heavy toll of workers, ranking just after handling objects as the greatest source of disabling injuries.
3. Falls from different levels frequently result in death or serious injury and compensation payments are substantially above those for other accidents.
4. Falls account for more than half the injuries to office workers, according to the U.S. Department of Labor.

Most falls can be prevented. They usually result from unsafe acts—running about unnecessarily, using makeshift ladders, rushing down stairs, not wiping up spills. Personal caution and knowledge are the best ways to prevent them.

By **H L CUMMINGS**, *Plant Manager*
and **H L MARSH**, *Chief Engineer*
R-P&C Valve Division
American Chain & Cable Co

Here's the 'inside story' on . . .

10 ways to protect valves

Plus these safety tips

Be sure valve design, material and construction are equal to the job

Lock, put warning signs on valves, on vessels in which men are working

Don't remove valve wheels. This may turn an emergency into a tragedy

Don't turn a valve stem with a wrench. If it needs this, it needs attention

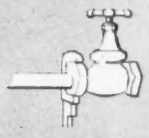
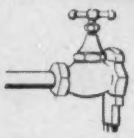
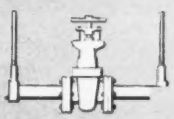
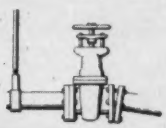
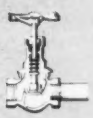
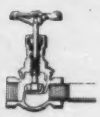
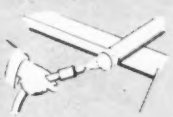
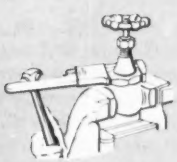
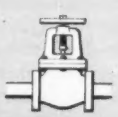
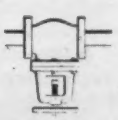
Inspect valves subjected to high pressure, temperature or corrosion frequently

► VALVES are the traffic policemen controlling and directing flow through the piping networks of American industry. And, like their human counterparts, their authority has to be maintained if they're to do a good job.

To help combat constantly rising piping maintenance costs, valve manufacturers are furnishing harder-wearing valve materials, better finishes, higher corrosion and abrasion resistance, and more practical design of components.

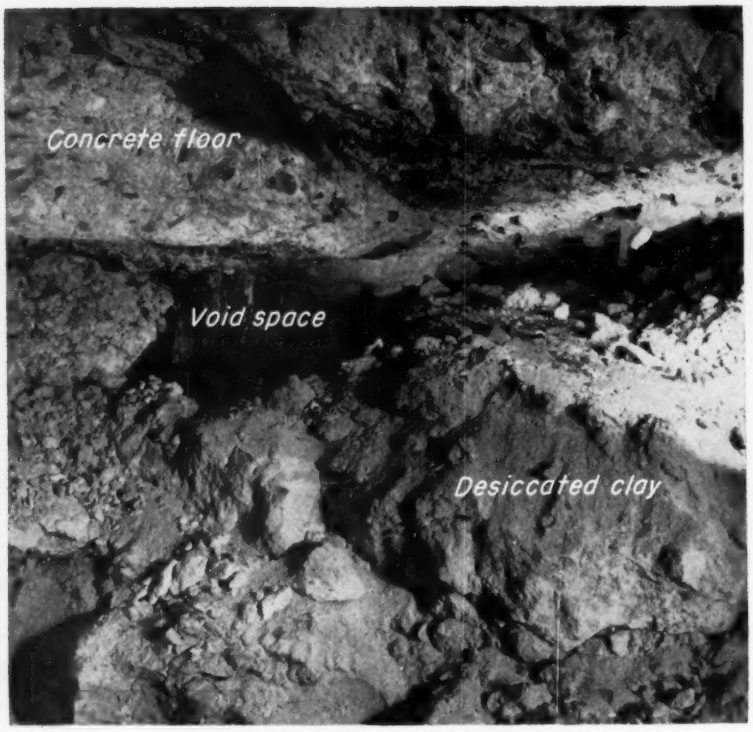
However, poor practice in installation, poor handling in operation plus lack of maintenance robs many valves of their built-in control potential.

It's common knowledge that the majority of valve failures could be prevented. And it's no secret that a lot of today's piping repair jobs cost as much, or more, than the original valve. The opposite page shows 10 common mistakes that give valves a beating.

	RIGHT	WRONG	
1			Use a wrench on the hexagonal connection near the joint. This gives support to the valve, prevents possible damage.
2			When installing a valve, keep it in the closed position. It's more rigid and less likely to be twisted.
3			Use good supports, expansion bands or joints. Don't force a valve to carry the weight, sag or expansion of piping.
4			Over-threading may let pipe shoulder against valve seat. Besides injuring valve this keeps joint from making up.
5			Pipe dope on end threads of valve means grit will appear on valve seat sooner or later. Put compound on the pipe threads.
6			Old pipe for a new or altered job is all right if the pipe is *clean*. Dirt or scale left in pipe results in valve trouble.
7			Leverage can murder a threaded joint. A short lever and a few hammer taps is more effective and won't twist the valve.
8			If valve is leaking, don't try to force it shut. This ruins more valves than anything else. Try to flush obstruction.
9			Gate valves and cocks may wiredraw if used for throttling purposes. Use globe or angle valves. These give a balanced flow.
10			Automatic stop and check or lift check needs upright positioning. Disk and piston must have a satisfactory gravity drop.

We literally had to dig for clues to solve . . .

The case of the settling boilers



THE SOIL under the boiler-room floor had dried out, dropped away about six inches

By **D M GREER**, *Greer Engineering Associates*

► ENGINEERS in a Southwestern power plant stared in disbelief at their low-pressure boiler room. The boilers, together with the boiler-room floor, were slowly but surely sinking into the earth. A quick check of bench marks told the engineers they weren't faced with an optical illusion.

Baffling part of the mystery was that some boilers had been installed for 23 years, others for 32 years. During that time there hadn't been any hint of trouble. But now there was trouble and, as time went by, regular measurements showed that settlement was consistent and continuous.

"Even though we hadn't established a sinking fund," grinned the chief engineer, "we knew the time had come to call in a consultant." And so he did.

First step was to cut test pits through the boiler-room floor. Photo shows the dry, powdery soil that was beneath. The soil had dropped about six inches from the floor. Since the floor was designed to be soil-supported, it was held up only by its contact with the building structure.

Testing the clayey soil showed that complete removal of the probable original moisture content produced shrinkage equal to the amount found. The boiler footings ran some distance under the floor, but they settled because boiler heat had dried the clay.

This explained the settlement, but still left the mystery of the time lag. In hunting solution a check was made of the boiler-room's history.

Following installation, the boilers were used continuously for a number of years. Then a new power plant took over and the entire boiler room went on standby with only occasional use. After ten years, it was returned to steady service.

Originally, the boilers were oil-fired. With combustion chambers about 2½ ft above the floor, air drawn through this space into the combustion chamber kept the floor cool. Consequently, the soil beneath didn't dry out except under the back of the boilers. Here, drying was due to heat (about 700 F) from the smoke tunnels.

Later, fuel was changed from oil to gas. At the changeover, space at the bottom of the boilers, formerly cooled by intake air, became part of the combustion chamber. The consultant concluded that the extensive drying and shrinking of foundation soil began at that time.

Now the boiler room was scheduled to go on standby again, as soon as a new addition to the power plant was completed. But one boiler couldn't wait. It had to be underpinned immediately. The others could get by if connected piping was periodically disconnected and adjusted to avoid strain.

Space under the floor wasn't grouted because when the boilers again went on standby, increased moisture would swell the soil. With grouting, swelling soil would rupture the slab.

A close check was to be kept on conditions for the life of the building. If necessary, the other boilers would be underpinned, or preferably, moisture added to the soil at periodic intervals to counteract further desiccation.

CHECKING POWER FACTOR on the spot with a clamp-on meter. This type of instrument is intended for balanced 3-phase loads

LEADING POWER FACTOR of synchronous motors offsets lagging inductive pf

Put your finger on power-factor offenders

► POWER-FACTOR CORRECTION where it will do the most good—right at the low-power-factor equipment—is getting a lot of attention in plants where utilization voltage is 600 volts or less. In many cases it's practical to attach shunt capacitors to a controller or motor so capacitor is switched along with motor. This eliminates capacitor switches. Capacitors may be connected to motor terminals; overload-protector current elements then carry corrected current. Or capacitors can be connected on line side of current elements to let current elements carry wattless current. Latter arrangement requires no calibration of overload relays when capacitor is added to existing installation.

Advantage of locating capacitors at source of kilovar load is reduction of current in cables, circuit breakers, fuses, switches and transformers, with resulting increase in their useful capacity. Where load consists of numerous small motors with different duty cycles, individual capacitors are uneconomical. Capacitors can be located on feeders with appropriate disconnecting means. Plug-in capacitors are made for use with bus-duct feeder circuits.

Clamp-on pf meter provides easiest means of tracking down low-power-factor loads in plants where there are many induction motors or other inductive equipment. Instrument is clamped on cable to measure current while clip leads are connected to each phase conductor to measure voltage. You read power factor directly on scale. Tests can usually be made without interrupting operation since connections needn't be opened for current measurement.

If size of plant doesn't justify investment in a clamp-on instrument, you can measure power factor by other methods. Use two wattmeters and appropriate curves; power factor in 3-phase circuits can be found by ratio between readings of the two meters. Similarly, power factor can be found if kilowatts and kilovars are known. You can always use wattmeters, voltmeter and ammeter to find power factor since power factor equals kilowatts divided by kilovolt-amperes. A clamp-on wattmeter makes it easy for you to measure power.

INDUCTION MOTORS with light loads have low power factor, high kvar load

Electrical Code changes at a glance

1956 *National Electrical Code* includes some revisions which affect plant electrical installations. Let's take a quick look at important points

Connection to grounded system

Transformers that have secondary circuit insulated from primary circuit may have secondary circuit grounded without having primary grounded. This was intention of 1953 *Code*, but some confusion arose from the wording of the section. It has been cleared up by a note explaining "electrically connected" as capable of passing current, and does not include the electromagnetic induction of an insulated transformer. An auto-transformer, on the other hand, is "electrically connected." *(Section 2002)*

Temporary wiring

A new section takes temporary wiring into consideration. The requirements are simple: Suitable disconnecting switches or plug connectors shall be installed to permit disconnection of all conductors of the temporary circuit by a single operation. No bare conductors or earth returns shall be used for wiring any temporary circuit. *(Section 3023)*

Neutral-feeder load

Experience with fluorescent-lighting loads has shown that even though the loads on the feeders of a 3-phase line are balanced, current in the neutral will be about the same as in the phases. Condition is caused by third-harmonic currents of fluorescent ballasts. To take care of neutral loads, new *Code* provides that in a feeder where load consists of 50% or more of electric discharge ballasts, there shall be no reduction in size of neutral conductor below size of phase conductors. *(Section 2203.g)*

Fuses in multiple

Fuses in multiple can now be used to protect motor branch circuits where ratings of acceptable fuses are not great enough to carry load singly. Same restrictions apply that have been in force for other circuits. Choose arrangement using fewest fuses. *(Section 2411)*

Length of taps

Length of unprotected taps from branch circuit has been increased from five to ten feet. The extension was made to meet needs of present equipment. Larger sized machines and control centers, and extensive use of bus duct have made the five-foot-tap rule inadequate. Same regulations apply. *(Section 2434.c)*

Grounding lightning arresters

Revision eliminates necessity of separate grounding conductor for lightning arresters installed on secondary service operating at 700 volts or less. Grounding conductor may be the grounded service conductor, common grounding conductor or service equipment grounding conductor. *(Section 2631)*

Underground feeder cable

Use of Type UF cable has been clarified. This cable is permitted in interior wiring in wet locations. Single- or multiple-conductor cable may be used in raceways; when installed as nonmetallic sheathed cable multiple-conductor cable is required. *(Section 3392)* Maximum permissible size of UF cable has been increased from No. 4 to No. 4/0. *(Section 93391)*

Conductor insulation

Among several changes in this section, most important is addition of Type RHH (heat-resistant rubber) with 90 C and dry location limitations. This new insulation is in the fourth column of Table 1, Chapter 10. Another addition recognizes silicone-rubber-insulated fixture wires, Types SF-1, SF-2, SFF-1 and SFF-2. At the same time, Type SBW (slow-burning weatherproof) wire has been deleted since it is not being used to any extent. *(Section 3102)*

Conductors in multiple

Use of parallel conductors in place of a single conductor has been extended to all sizes 1/0 and larger. Formerly largest size permitted was 500,000 cir mils. Conductors must be same size, length and type. *(Section 3105)*

Aluminum conductors

Two new tables, 1a and 2a, have been included. They give allowable current-carrying capacities of aluminum conductors. New values depend on conductor size while old ratings were a flat 84% of those given for same size of copper. Aluminum conductors have been added to Table 18a, multiplying factors for converting dc resistance to ac resistance. *(Section 3106)*

Armored cable

Use of armored cable (Type ACV) has been extended to commercial buildings as well as industrial buildings. (Section 3342) Where armored cable connects to other types of cable or conduit, a junction box is required. This eliminates practice of stripping off armor for a length of the cable and running the unarmored cable in a section of conduit, using a coupling to connect cable to conduit. *(Section 3347)*

Ungrounded conductors

This section was modified to remove unintentional restrictions on use of single-pole circuit breakers on 277-volt lighting circuits. Old *Code* limited single-phase lighting circuits with grounded neutral (no circuit breaker in neutral) to 150 volts to ground. *(Section 2405)*

Cellular concrete-floor raceways

A new article regulates use of cellular precast concrete-floor raceways. Hollow spaces in floor are converted to raceways by metal fittings designed to provide access to the floor cells in an approved manner. A grounding conductor should be provided for grounding metal fittings. *(Sections 3581-3591)*

Fractional-hp motor protection

Any motor of one hp or less that is not portable, even though manually started within sight of the operator, requires overcurrent protection other than the branch-circuit protective device. *(Section 4322.b)*

Thermal protectors

Rewording of section permits use of thermal protectors for motor-running protection that do not simultaneously open all ungrounded conductors. (Conductors are opened in rapid succession.) Thermal protectors are now in class with fuses and thermal cutouts. *(Section 4328)*

Differential protection

This important method of protecting ac motors has been recognized and its status with respect to the *Code* established. *(Section 4424)*

Transformer vaults

New regulations concerning walls, roof and floor of transformer vaults allow other forms of fire-resistant construction provided they have adequate structural strength for the conditions and minimum fire resistance of 2½ hours according to specifications of ASTM *Fire Test Standard E119. (Section 4542)*

Hazardous locations

Several changes have been made in this article. Most significant probably is a provision for drainage of liquid likely to accumulate in certain locations under moist or wet conditions. The new paragraph says, "such means shall be provided at the time of manufacture, and shall be deemed an integral part of the machine." This requirement may make some installed equipment obsolete. *(Section 5015.c)*

Motor full-load current

Running currents for full load have been increased for dc motors, ¼ through 3 hp (Table 21) and single-phase motors, 1/6 through 1½ hp (Table 22). The higher ratings are a result of design changes that use less material in the motors which lowers efficiency. *(Chapter 10)*

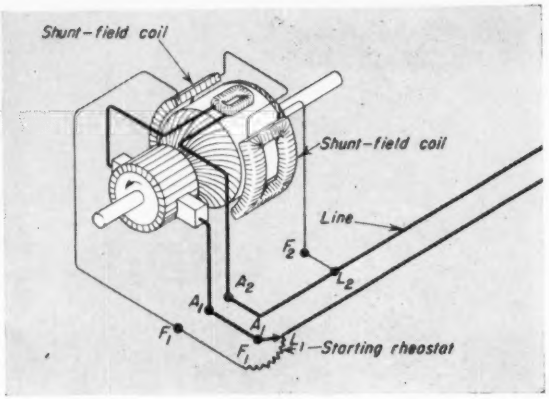
Plant

Electrical Fact File

NO. 11: DC CONNECTIONS

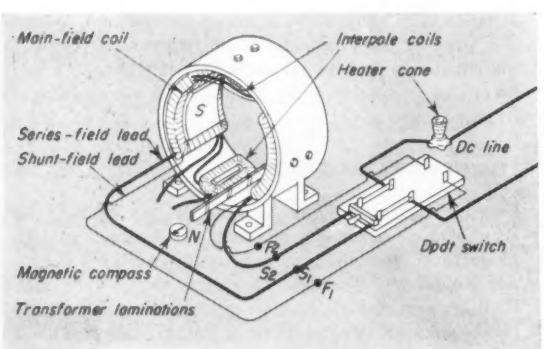
Connecting dc motors

► NOW THAT DC MOTORS are getting wider application, taking care of them is likely to be part of any maintenance electrician's job. There's no mystery about dc motors, but it's necessary to connect them correctly and test them before putting them in service. There are many ways of testing for proper connections, each best suited to a particular case. Those described are among simplest and most reliable. But you've got to perform tests carefully to avoid mistakes. For example, don't let magnetic compass become *remagnetized* by field flux. Provide adequate means to control test current, and protect circuits from shorts and grounds that may occur while you're testing.

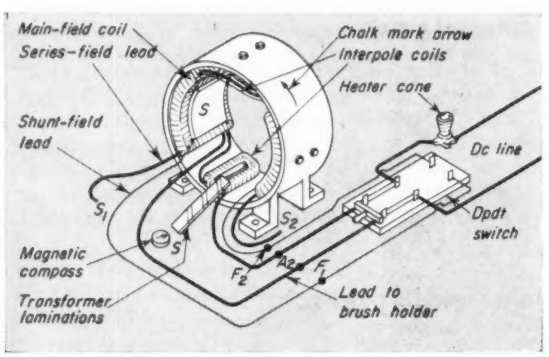


SHUNT MOTOR has field coils and armature in parallel across line. Standard lead markings for counterclockwise rotation are shown. Motors usually have interpoles; they're in series with armature. Starters are needed above one hp. Starter resistance is all in armature circuit at start, ends up in field circuit. It's insignificant compared with resistance of the field.

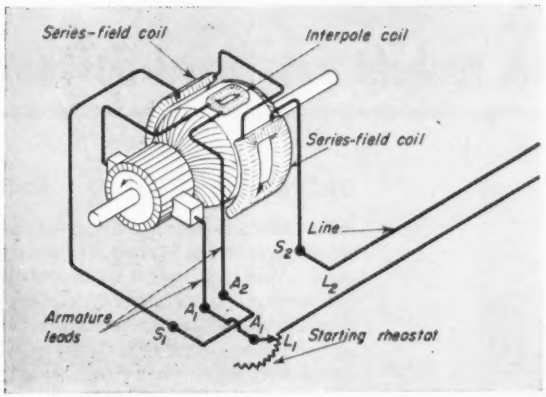
By **NORMAN PEACH**, *Assistant Editor*



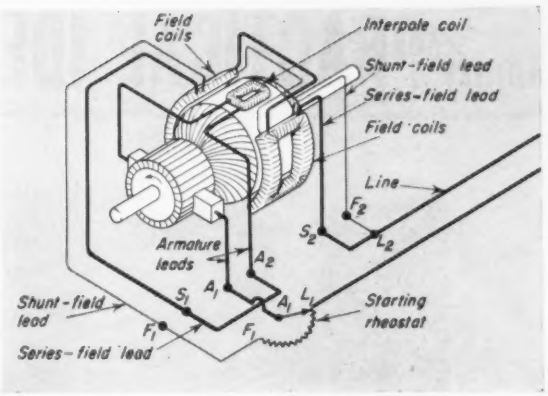
POLARITY TEST performed with motor disassembled. Using magnetic compass and soft iron "detector" like bundle of transformer laminations, check that shunt field poles are alternately *N* and *S*. Mark polarity on pole pieces with chalk. Check series field in same manner, being sure polarity of shunt and series fields coincide. Tag leads and tie S_2 and F_2. You may need full-load amperes for series field.



INTERPOLE POLARITY should be same as that of *preceding* pole in direction of rotation. Select interpole leads so polarity is correct for counterclockwise rotation and mark chalk arrow on frame. After assembly, if motor runs opposite to arrow, reverse rotation by *interchanging leads on brush holder.* If there are as many interpoles as main poles, they'll alternate *N* and *S*. If half as many, they'll all be *N* or *S*.

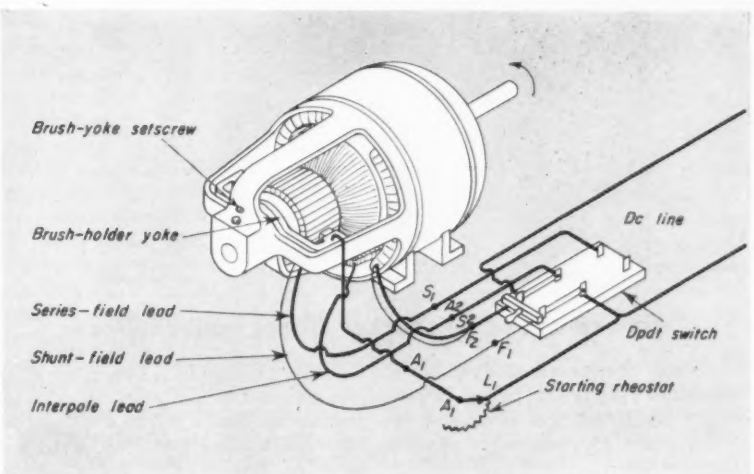


SERIES MOTOR has field coils, armature, interpoles and starting resistance all in series when starting. Series motors are often used for drives where speed and torque are varied by changing the external resistance. They'll overspeed if their load is removed, perhaps to extent of flying apart. Hoist and traction motors are usually of series-connected type.

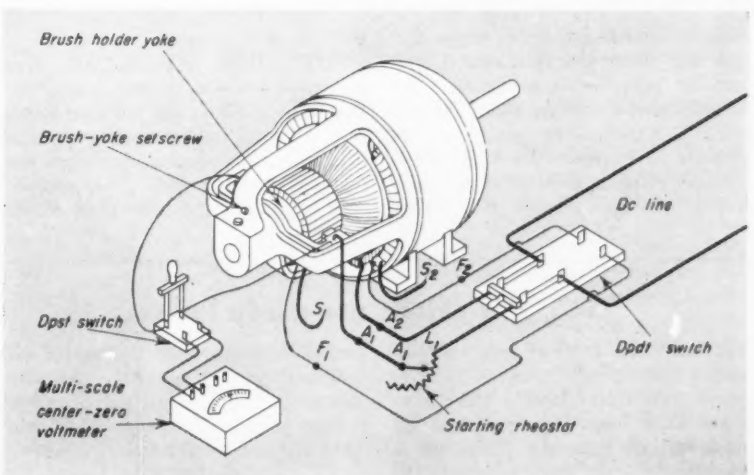


COMPOUND MOTOR combines series and shunt fields. In cumulative-compound motors magnetism of the two fields is added to give increased torque as load increases. Differential compound (fields bucking each other) is rarely used; motor tends to speed up with load. *Stabilizer-shunt motor* has same hookup as cumulative compound, but fewer series turns.

CUMULATIVE FIELD TEST employed in case disassembly is impractical, tells if shunt and series fields are bucking. With S_2 and F_2 tied together, run as shunt motor then as series motor. Rotation should be the same. Battery can be used to supply series field current, taking care that current flows in same direction it would if taken from the regular dc line.



BRUSH NEUTRAL TEST: Connect voltmeter to brush holder studs, starting with high-voltage scale. Open field circuit; inductive kick shows on meter. Shift brush yoke until voltage kick is minimum, changing to millivolt scale. Or, if you're *certain interpoles are connected right,* you can find brush neutral by putting current through armature and interpoles only, and shifting brush yoke until there is no tendency to rotate. Conversely, check interpoles by shifting brushes 1/3 pole pitch; if rotation is in *direction of brush shift,* the interpoles are right.



Smart PRACTICAL IDEAS *to help you speed up your*

Homemade scale cracker cleans boiler tubes

There are three ways to clean used boiler tubes: (1) tumble tubes in a barrel (2) tumble tubes on a sling of revolving chains (3) pass tubes between knurled rollers.

We made a scale cracker from odds and ends. The knurled rollers are government-surplus double sprockets that look like motorcycle sprockets. Upper sprocket or roller is manipulated by the long lever extending out of the picture. This long lever exerts enough pressure on rollers to break the scale.

Upper roller is swiveled at an angle, feeding the flue through the rollers. Power is supplied by a 2-hp motor that drives an automobile gear box. Box is near the machine's bottom and reduces speed. Box offers four speed changes, including reverse. Coil spring shown counterbalances long lever's weight and holds the top roller clear of flue until lever is operated.

This machine takes up little floor space and is not as noisy as a common flue rattler. While our machine seems best suited for smaller operations, some of the larger modern boiler shops use this method—and with great success.

H W Stowell, *Albuquerque, N. M.*

Long, thin chisels are handy tools

You can make a set of long small-diameter chisels from ¼-in. drill rod to get in those close places. I make mine about 10-in. long. I've used them for conduits, lock nuts, slip joints, motor windings, etc. Be sure to harden and temper them properly. Be careful not to burn the cutting edges when drawing to a temper. Best color is dark yellow to light orange. Then edge won't chip when using on tough metal.

C G Howarter, *Canton, Ill.*

Did you know . . .

that 438 cases of lightning damage were reported by Factory Mutual insured plants last year? Lightning damage to your plant's power system can occur from (1) a direct stroke (2) an electrical surge (3) release of bound charges.

Direct stroke usually harms outdoor equipment. Sprinkler piping or other grounded metal in the building framework has effect of shielding indoor equipment against direct stroke.

Surges are produced when a bolt strikes a transmission line or some object near it. Surge is a high-voltage current that travels along a line in both directions at high velocity. Unless you have protective devices, your insulation in motors, generators and transformers will break down.

Bound charges are built up on all conductors at or near the earth's surface when a charge cloud passes overhead. These charges are "bound" as long as the cloud remains charged. But when the cloud is neutralized by a lightning stroke to earth, or to another cloud, charges are suddenly released. Charges seek easiest path to ground, often ignite combustible material. Electrical insulation is often punctured.

Lightning arresters are the usual protection for motors, switchgear, etc. They are effective against direct strokes, surges or bound charges. Except on the Pacific Coast where thunderstorms are infrequent, arresters are an essential part of a plant's electrical system.

Place arresters as near as possible to equipment terminals you're protecting. Arrester selection and installation is a highly specialized subject requiring assistance of equipment manufacturer.

Ground connections, to be effective, must have a resistance of 5 ohms or less. Underground cast-iron water mains with lead joints make the most reliable grounds. Rods or pipes driven to a depth of 6 ft are OK in some soil and are easy to install. Copper plates, at least 9 sq ft, buried vertically or horizontally at an average depth of 4 ft, are used at most power stations.

Experience shows that ground resistance does not remain constant. It's important to test these grounds once a year. Mutual Bulletins 15.66 and 15.60 go into details. Be sure to send for them. *Courtesy, Factory Mutual Fire Insurance Companies, Boston, Mass.*

operation and maintenance jobs

STEVE ELONKA, *Associate Editor*

Have you tried sawdust?

H C Zwart, POWER, Sept 1956, p 121, tells how a skin diver sealed a leaky wooden tank, filled with water, from the inside. Many of us old-timers would never think of using these new methods.

I've sealed wooden tanks by dumping sawdust inside and letting the rising water distribute the sawdust along the sides as the tank filled. The water would force the sawdust into the cracks, where it would swell and seal the leaks. Chopped straw was another old standby.

On one job I had great success by using straw and dried grass to seal a brick intake from outside leakage, just beyond a shutoff valve. I thought younger engineers might want to know of these old lifesavers that we used.

C O VON DANNENBERG, *Brooklyn, N. Y.*

Here's what I would have done

First thing F I Gillmor, POWER, Nov 1956, p 133, should have done was to play that water hose on his wood fire. That's strong medicine but I'm sure conditions warranted it.

J O'GARA, *Long Island City, N.Y.*

Me too...

Any boiler that has water at the bottom of the glass and is still losing water has a serious problem. I would immediately check draft below and in uptake or stack, smother the fire with wet ashes, wet fuel, or anything. Then I'd dump the grates, open fire doors to cool, block all chances of fuel getting combustion. While so cooling her, I'd continue to feed the boiler ever so slowly with the pump or injector. Then I'd find a way to get extra water to her.

One way is to have a hook-up to blow down if city-water pressure is sufficient. You can get water to boiler through any live steam opening if you have a connection. Higher pressure is much quicker and less trouble than the gage-glass method.

I'm sure a boiler with the condition described by Gillmor demands correction at once. I would not continue steaming unless I had a sure way to feed it. If city-water pressure is high enough, it should be properly hooked up for such emergency feeding.

C H WILLEY, *Penacook, N.H.*

What would you have done?

One Sunday night I was urgently called to a shutdown plant to help them get on the line. They had three single-retort underfeed stoker-fired boilers of 400 hp at 250 psi. Boilers were only 6 months old but the previous chief had neglected the stoker windboxes. Boxes were so bad that fire had almost destroyed the stokers—only the grates were OK. Stoker rams and operating mechanism were also badly burned and wouldn't work. Windbox supports under stoker frames were so severely burned that stokers sagged and were way out of line. And grate supports were in sad shape, too.

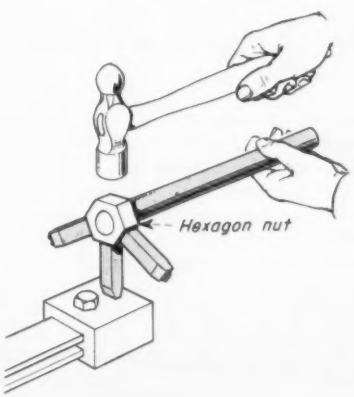
Consulting engineers called in had advised a 2-week shutdown to put boilers back in shape. After a quick inspection, I promised to have plant on the line the following Tuesday morning—or in 36 hours. Management gave me the kind of horse-laugh Marmaduke Surfaceblow often gets when he bucks highbrow consultants. But I stuck to my promise and, like Marmy, I bet a suit of clothes that I'd make good.

Stokers were beyond use without costly repairs, so I planned to resort to hand firing. I put a repair crew to work early on Monday. We made jacks from studs and pipe sections. They were used to get the grates which supported the frames back close to their original position. While this was being done, I drove to a neighboring city where a large plant had recently converted from hand to stoker firing. I took three of their good hand firemen back to the plant with me.

My plan was to build piers under the grates after I got them back into their original position. Lack of time prevented this, so we had to let the grates sit on the jacks until we could build the piers later. With experienced hand firemen, we had coal dumped on the boiler-room floor instead of into the hoppers.

The firemen got started on Monday evening and we had steam up in time for starting by 7 am on Tuesday. Plant was hand fired until boilers could be overhauled properly. I won the suit of clothes. What would *you* have done?

W W COLEMAN, *Rock Hill, S. C.*



Make hand-stamps handier

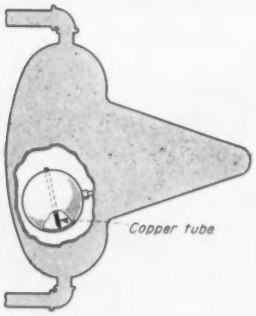
Maintenance men who mark positive, negative, amps, volts, dc, ac, etc, on shunts, terminals, name plates, will find tool, shown, very handy. One of our boys cut stamps down and welded them to three faces of a steel hexagon nut. Then he made a shoulder handle, screwed it to the nut. This enabled him to use several sets with the one handle. Tool saves time and stamps aren't as likely to get lost or misplaced.

C H WILLEY, *Penacook, N.H.*

Turn page for more Practical Ideas ►

More PRACTICAL IDEAS

Begins on page 130



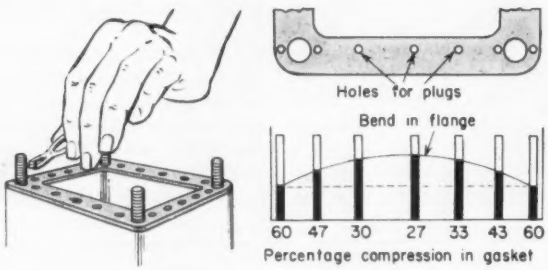
Here's your trick of the month

Inspecting the ball float of our evaporator for a leak, we found a lot of small cracks at right angles to circumference weld. We tried to weld the float with various rods and fluxes without success. We'd have to wait a week for a new float. But in the meantime, we had to keep our evaporator in use.

We thought of various methods, such as manual control, taking float chamber apart and draining the float at various times, making a box-type sheet-iron float. Then an idea struck me. I drilled a 3/16-in. hole in the float's topside and inserted a piece of 3/16-in. copper tubing, cut at an angle, sketch. I cut the tubing off about ⅛ in. above the float and expanded it tight in the 3/16-in. hole with a punch. We installed float in its cage and put evaporator in service.

Since our evaporator operates at about 30 psi, we could relieve the shell pressure by closing the vapor line and opening the drain valve. As pressure in the float chamber began to lessen, the pressure in the ball float forced the water up through the copper tube. Since the cracks did not cause a rapid leak, we had only to drain our float once a shift. When the new float came we found our old float bone dry.

O HOKSCH, *Lansing, Iowa*



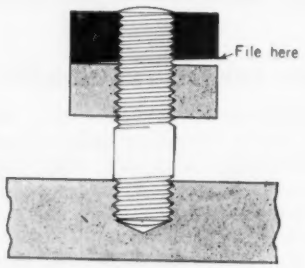
Now we know why the chief kept blowing his gaskets

To know why a gasket blows often takes a little detective work. When gasket shown kept blowing each time it was renewed, here's what our engineers did. They drilled tiny holes in gasket, then inserted tiny solder plugs of the same thickness as gasket. After tightening the four bolts evenly with torque wrench, the solder plugs were removed one by one and measured with micrometer. Curve at right tells the story of trouble at a glance.

This curve shows that while resilient gasket returned to original thickness, the solder plugs did not. That proved gasket was not fully loaded away from the four bolts, causing it to blow.

In this case there was one of three ways to solve problem: (1) increase thickness of gasket (2) make gasket narrower (3) stiffen machine's flange to keep it from bending. You plant engineers can probably put this excellent idea to many uses in your work.

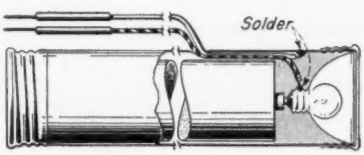
Courtesy, Armstrong Cork Co, Lancaster, Pa.



Simple stud puller

You can easily pull or set a stud without looking for a special stud driver or puller. File or grind the top of one nut at a slight angle so it's no longer perpendicular to threads. When assembled on stud with a regular nut, this face will be adjacent to the regular nut, sketch. Then you can use one wrench to drive or pull the most stubborn stud. Nuts can be removed with one wrench.

R B DODDS, *Wellsville, N. Y.*



New use found for old flashlights

I found a dozen old flashlights in a desk drawer at our plant. Most of them had been discarded because the switch was broken or because they failed to work. Thinking they still were of service, I made them into simple circuit testers as follows:

I removed the switch completely. Then soldered 3 ft of stranded copper wire to the barrel's inside, sketch. Another length of wire was soldered to casing holding the bulb. Both wires were brought out through the switch hole and test probes attached to ends.

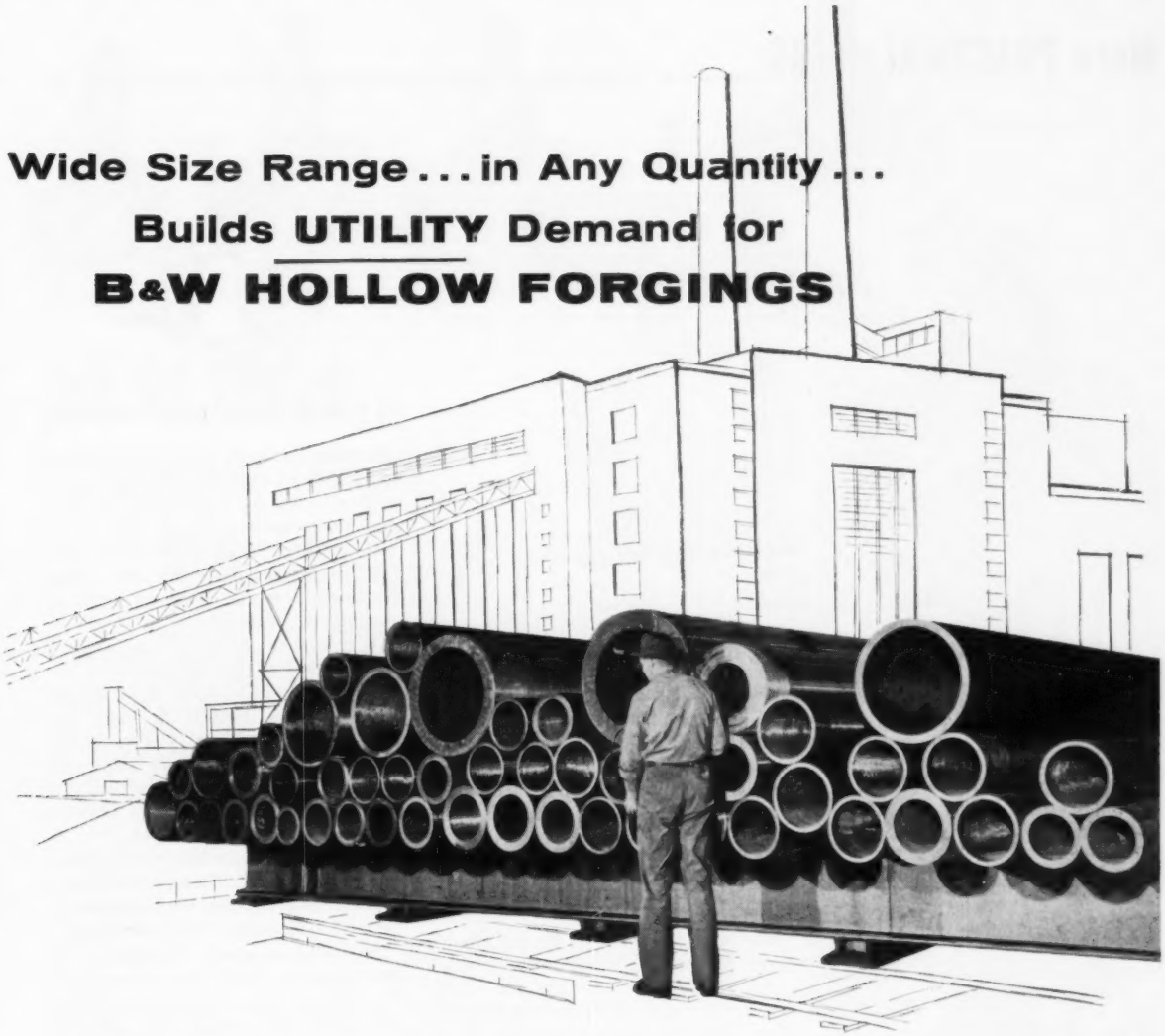
I reassembled flashlight, added batteries and a bulb. A couple of turns of electrical tape were wrapped around the barrel's end to hold test probes when not in use.

Any conductor, placed between test probes, completes the flashlight circuit, causes the bulb to light. This tester has come in handy on numerous jobs such as checking fuses, control circuits, continuity through switchgear, combination motor starters, etc.

D E ALBRIGHT, *Houston, Texas*

Turn page for more Practical Ideas ►

Wide Size Range . . . in Any Quantity . . .
Builds UTILITY Demand for
B&W HOLLOW FORGINGS



Leading Electric Utilities—like American Gas and Electric, Carolina Power & Light, Commonwealth Edison, and Wisconsin Electric Power—use B&W hollow forgings for main steam, reheater, feedwater, and similar lines. B&W hollow forgings give them a sound solution to their piping problems.

These heavy-duty forgings can be specified to exact design requirements. They are made from high quality carbon, alloy, and stainless steels. They are produced with vigilant care under controlled conditions from the initial melt through final inspection. That's why B&W hollow forgings give users savings in time and money.

Because of B&W's specialized manufacturing process, hollow forgings can be made in special shapes or with special end preparations, such as end closures, reduced sections, and Van Stone flanges.

For additional information, write for Bulletin S-16B. The Babcock & Wilcox Company, Process Equipment Department, P-2, Barberton, Ohio.

Ask for this Bulletin: S-16B

BABCOCK & WILCOX

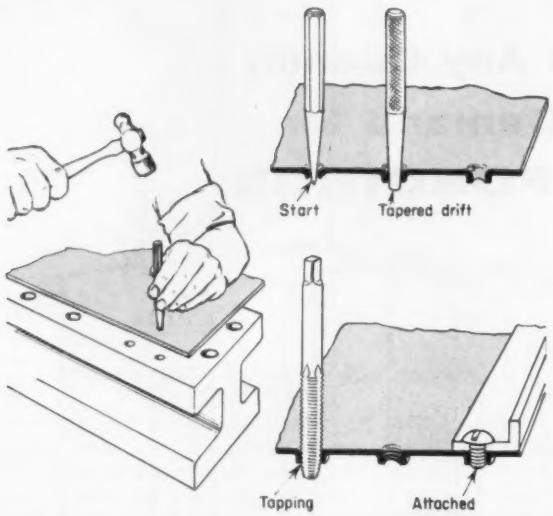
B&W

BOILER DIVISION

S-466-HF

More PRACTICAL IDEAS

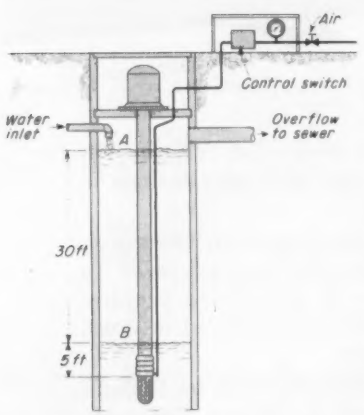
Begins on page 130



Extruded holes in sheet metal are better

You often have to attach things to sheet metal. For a stronger job, strengthen hole as shown. You can tap threads in these extruded holes, or use self-tapping screws with greater holding power. Use a few different size drifts and hammer on a steel plate or anvil that has various sized holes. A little practice on odds-and-ends of scrap metal will give you some surprising results. And fastenings will last much longer because you'll have enough threads to prevent stripping.

C H WILLEY, *Penacook, N.H.*



This pump's control works

Float switch for pump, POWER, Oct 1956, p 130 by P C Ziemke is interesting. But his switch wouldn't work for us. My sketch shows switch used to control a pump in an old well about 30 ft from our power plant.

We dump cooling water from turbine oil-cooler, backwash from filters and softeners and cooling water from air compressors into this well for recovery. It's then pumped back to our lake to be recirculated. We had trouble with rust caused by moisture in switch and chain. Also, bearings for wheels carrying chain would rust and not allow switch to operate properly.

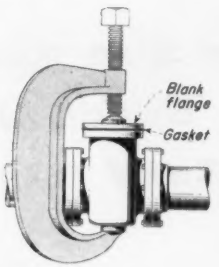
I installed a pressure control switch to operate in reverse, then dropped an air line to bottom of turbine pump shown. Air valve is cracked to keep line full of air. When water is at level *A*, there is 15.52 psi on control switch. This switch closes the magnetic circuit on starter for pump motor and starts pump. When water is at level *B*, there's 2.16 psi on control switch. This allows switch to open magnetic circuit and stop the pump's motor.

This control has given us two years of trouble-free operation. Besides, we have had very little routine maintenance, which was a headache before.

C A GILL, *Richmond, Va.*

Does your roof...

bake your employees beneath it, or do you cool it to make employees happy? Three types of roof sprays and information on roof cooling are clearly illustrated in new *Plant Operators' Manual*, McGraw-Hill Book Company.



C clamp keeps plant running

We burn bunker C fuel in our boilers. Oil is heated in five multi-film heaters of two banks. All heaters are fed from one main auxiliary steam line at 100 psi. One bank has a cutoff valve, other bank does not. Also, the line cannot be isolated except from the auxiliary desuperheating station.

Our system is critical as we also furnish fuel oil for ten cement kilns; five of them have waste heat boilers. These furnish 100,000 lb steam per hour for our turbines. Any prolonged shutdown of the oil heaters would seriously interfere with production. Oil flow through the heaters is approximately 4500 gallons per hour.

One day a steam-line valve bonnet gasket blew out. This called for a quick repair because we had to maintain oil temperature for production.

We used a piece of half-inch flat steel plate, a gasket and a heavy-duty C clamp to solve the problem. Gasket and plate were coated with high-temperature gasket compound. We loosened two of the bonnet bolts, then cut off steam to heaters. When the line was bled out, we removed the other two bonnet bolts. Then the steel plate and gasket were put in place and secured with the C clamp. Steam was turned on again while we made the new gasket, sketch. When finished, steam was shut off, plate and gasket removed and new gasket installed. Then bonnet was bolted in place.

Steam was off for only five minutes each time. Loss in oil temperature was less than 30 degrees while steam was off. Entire job took under 30 minutes.

N G JACOBS, *Oro Grande, Calif.*

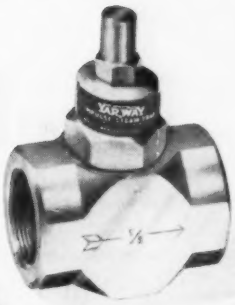
My biggest boner

Please turn to page 204

½" No. 60 or 120

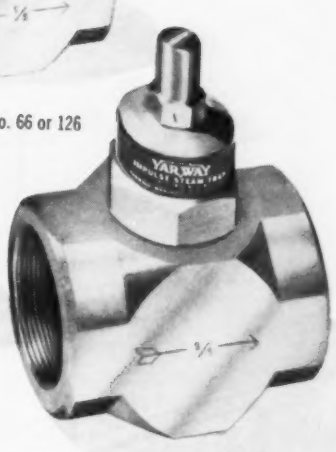
¾" No. 61 or 121

1" No. 63 or 123



1½" No. 66 or 126

1¼" No. 64 or 124



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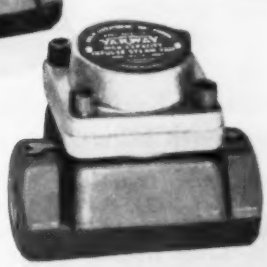
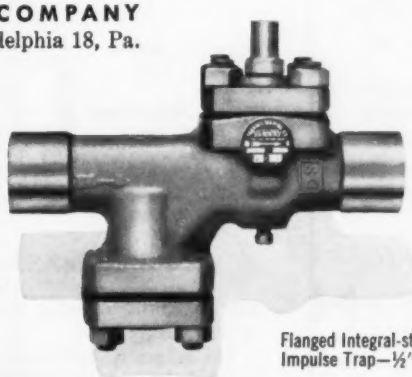
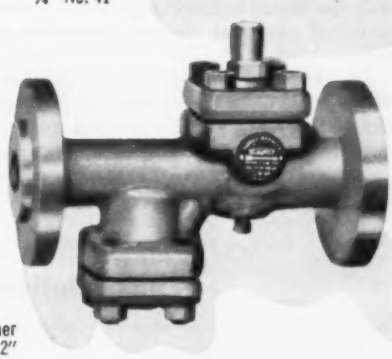
½" No. 40



¾" No. 41



Socket-weld Integral-strainer Impulse Trap—½" to 2"



Flanged Integral-strainer Impulse Trap—½" to 2"

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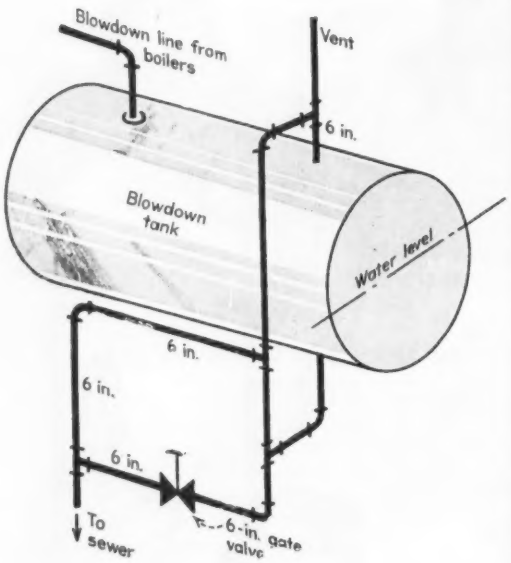
Have a PLANT PROBLEM? Tap the



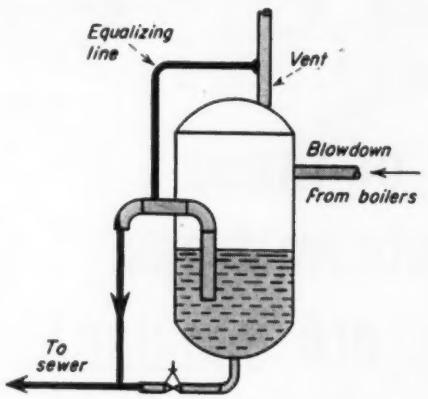
The problem

What's best way to operate blowdown system?

One of the engineers in our plant claims that the right way to use the blowdown system shown above is to open the 6-inch gate valve after blowing down the boiler. Operator should close valve after the tank is drained. This, supposedly, is to allow plenty of room for the next blowdown from the boiler.

I believe that the valve should be closed at all times. It should be used only to drain the tank. But if I'm right, why use a 6-inch gate valve just to drain a tank? I'd like to get opinions, experiences of *Power* readers.—*PCO, November Power*

The solutions

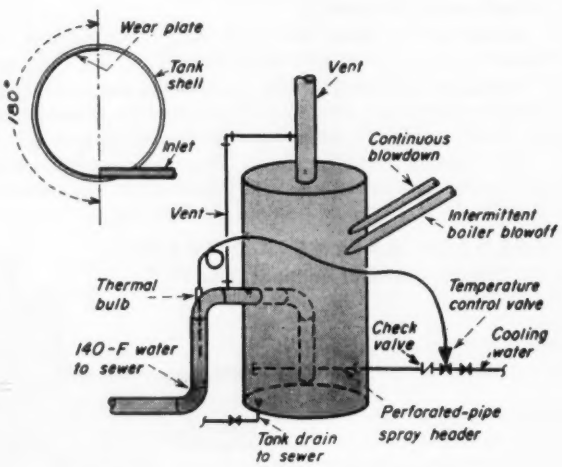


Tank should keep hot water from entering sewer

Job of a blowdown tank, sketch above, is to keep hot water from entering the sewer. Entrapped water cools in the tank during the time interval following boiler blowdown. Cooled water is displaced by incoming hot water from the boiler.

By allowing only cool water to enter the sewer, possible damage from hot water contacting sewer lines is avoided.

D W ANTONACCI, *Pensacola, Fla.*



Tank is for flashing and cooling

Sketch, above, shows a method I've used for several 100 to 150-psig systems.

The tangential inlet allows blowdown water to flash into steam before hitting lower part of the tank. The internal overflow pipe maintains a water level in the tank at all times and also prevents flash steam from entering the drainage system. Cooler water drains from the bottom of the tank.

H A BERSON, *Peekskill, N. Y.*

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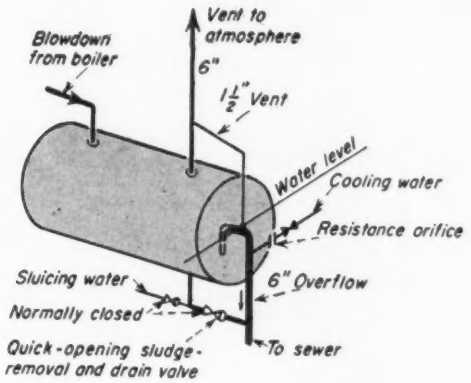
HOWARD KALLEN, *Associate Editor*



Install an inverted "U" seal

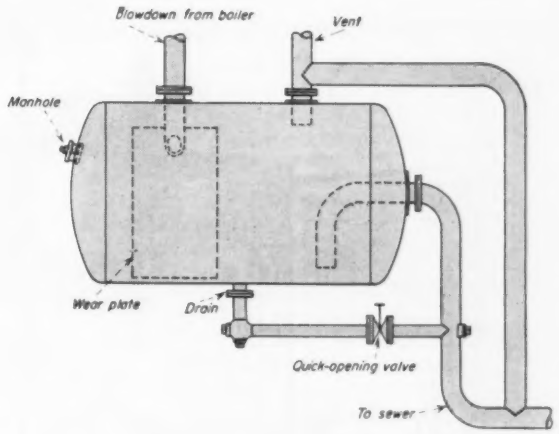
PCO can simplify blowdown by having valves operate less frequently. He can do this by changing piping to follow the sketch above. The seal inlet should be about 6 inches below normal water level to avoid direct blow through.

Periodic sludge removal is through the rearranged piping at bottom of the tank. By opening the sludge disposal valve and the sluicing water valve, the tank can be drained quickly and the valve flushed of sludge.

Cooling-water supply to the overflow line reduces water temperature, prevents flashing in the sewer system. Orifice in the cooling-water line allows a small continuous flow. *PCO* should also install the 1½-inch vent line to prevent siphoning action.

A water level should be retained in the tank at all times to reduce blowdown to the saturation condition. And it's also necessary to have a manhole and internal wear plate.

A J BREUGELMANS, *New York, N. Y.*

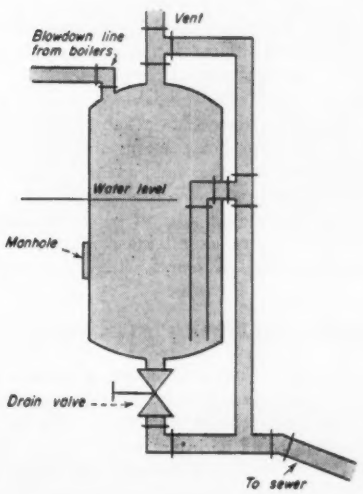


Engineer should open 6-inch gate valve after blowing down boiler

Reason for the blowdown tank is to allow water under pressure to reach equilibrium at tank conditions. The process produces steam and cools remaining water, allowing it to enter the sewer. For the tank illustrated by *PCO*, the engineer is correct when he opens the 6-inch valve after blowing down the boiler.

Drawing, above, shows a popular blowdown system with tangential inlet, siphon discharge and a relatively small quick-opening valve to drain the tank. Tank should be designed as an ASME *Code* pressure vessel because the steam is produced in a greater quantity than can be handled instantly by the vent line.

J BORESTA, *West Englewood, N. J.*



PCO doesn't need a 6-inch valve

A blowdown tank serves two purposes: (1) It is an area in which blowdown water flashes to steam plus saturated water at atmospheric pressure. (2) It acts as a cooling device and a water seal.

The vertical tank, left, is best because of the greater height of water, reducing chance of mixing effect between hot and cold water. *PCO* should use a gate valve on his drain but he doesn't need a 6-inch valve. He should drain tank only if he is going to work on it or lay it up for a long time.

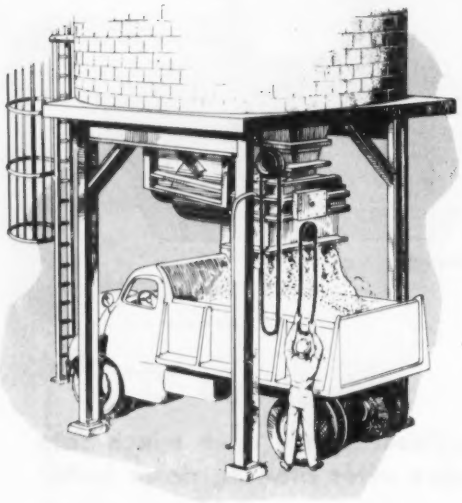
I A KAYE, *Springfield, Mass.*

Want help with your plant problems? Send your design and operating headaches to us. We'll give Power readers a whack at them.

Turn page for info on ash disposal ▶

More PLANT PROBLEMS

Begins on page 136



The problem

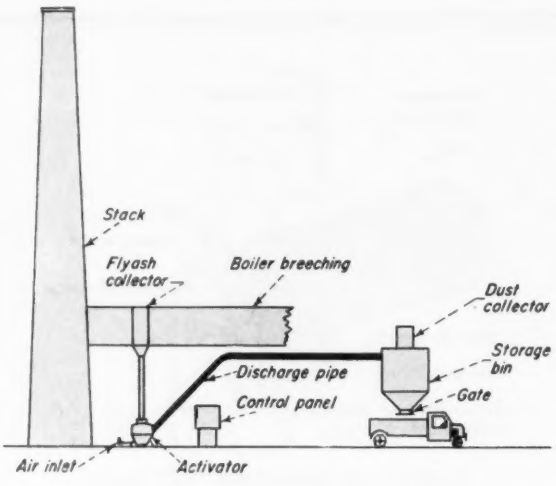
How can we dispose of ash after collecting it?

Much information is available on the proper collection of flyash but little is said in the literature about the disposal of this ash after collection.

We have two 10,000-lb-per-hr spreader-stoker-fired boilers. They're equipped with mechanical flyash collectors. Flyash is reinjected from the hopper into the last pass of the boiler, but not from the collector itself.

We collect about seven cubic feet of ash per day. How can we dispose of it with a minimum of expense and without creating a nuisance? Perhaps some *Power* readers have found good solutions to this problem.—*HDF, November Power*

The solutions



Try pneumatic conveyor system

Sketch, above, shows an air activated conveyor system. It's well-suited for handling abrasive materials. An activator (pressure vessel) collects the flyash. When full, the material inlet valve closes. Air is admitted to the activator; the flyash is fluidized and flows to the storage bin. Dust collector, on top, removes the fines and returns them to storage. Removal from storage is by truck or car.

Such systems are commercially available. They are equipped with either manual or automatic controls.

G GRIFFEL, *Bronx, N. Y.*

Here are several possible answers

Flyash disposal is almost always a problem, but seven cubic feet per day is a small quantity. Spreader-stoker ash of this type can be high in combustible. In fact, it may run as high as 40%. *HDF* might find it practical to pulverize this material and blend it with the original coal supply.

For disposal only, this plant might try mixing the stoker ash with a small quantity of cement. A dampened mixture like this can yield a satisfactory stable product.

Some high-carbon spreader-stoker ash—35 or 40% carbon—can be used this way: Pulverize to a fine particle size and market it as a substitute for low-grade graphite. Some foundries can use such material as a mold-dusting compound.

Stoker ash can be used as a low-grade fuel. But I doubt seven cubic feet per day would interest potential users.

H H RUSSEL, *Project Engineer*
Bituminous Coal Research, Inc, Pittsburgh, Pa.

Consider sintering the flyash

If *HDF* sinters his flyash he could create a market for it. Since he is quite a small producer it probably wouldn't pay him to install a sintering plant. But there may be other plants in his area that would be interested in a joint venture.

J PAPAMARCOS, *Oroya, Peru*

For more on ash disposal and new problems, turn page ▶

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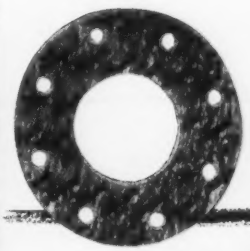

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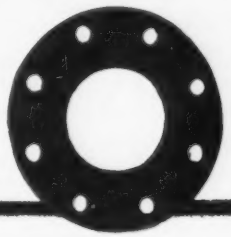

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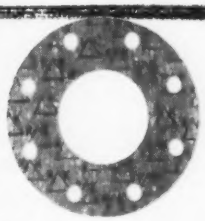

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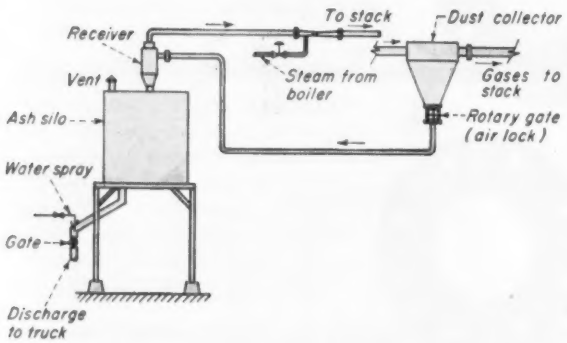
More PLANT PROBLEMS Begins on page 136



Vacuum systems do the job

Steam-jet and vacuum systems are often used for ash removal. In the first type, steam mixes with and moistens the ash. This design yields good results in handling ash from underfeed stokers. But for the fine ash from spreader stokers, the moist mixture makes removal difficult. Vacuum systems generally get the nod for spreader-stoker installations. They provide maximum cleanliness and simple design.

Sketch, above, shows an arrangement that can be installed at moderate cost. Removal of flyash and dust from the silo to a covered truck or gondola car reduces spread of dust. If covered vehicles aren't used, moistening with water will help to reduce the problem to a minimum.

H B WAYNE, *Woodhaven, N. Y.*

How about flyash reinjection?

Returns from a dust collector aren't 100% ash. *HDF* should know flyash may contain substantial amounts of combustible.

An acceptance test, in 1951, on one of our spreader-stoker-fired boilers showed 83.36% of the flyash was combustible and its heat value, 11,850 Btu per pound. We decided to reinject the ash to the firing grate. To do the job, a nozzle was installed through the bridge wall. We were somewhat concerned at first and expected clinkering. But the problem never showed up.

Objection advanced against reinjection: A certain amount of ash is recirculated through the collector. This, of course, is true but we haven't found it objectionable.

Steam-jet ash conveyor to pipe the ash from the hopper to an intake is another way to handle the job. But even with an air washer *HDF* will have a greater dust problem.

G KNUTH, *Appleton, Wis.*

Flyash makes good fill for gullies

If there's a stream or low-elevation area near the plant, *HDF* may be able to sluice the flyash into it without violating any anti-pollution laws. It's a simple solution to the problem. Otherwise, ash will have to be collected in a bin and hauled off in a dump truck. It makes a good fill for gullies and low ground. But it must be covered with a layer of dirt to keep it from eroding and blowing away.

If flyash is sluiced into a stream or low area, steam or water-jet conveying system can be used without a cyclone or storage bin. If *HDF* hauls it away he'll need a storage bin that should hold at least one truck load of flyash.

To haul dry flyash, truck must have a dust-tight body together with dust-tight connections between storage bin and truck. We use a dustless unloader. This consists of a tilted-rotating drum. Shaft through the center supports stationary scrapers and several spray nozzles. Flyash is fed into drum's upper end and is dampened by the water spray. It then comes out of the lower end, into the dump truck.

E W MCKNIGHT, *Chapel Hill, N. C.*

Your February problems

1 Should we use centralized or decentralized maintenance?

I've just taken over the job of plant engineer for a new plant that consists of two one-floor manufacturing buildings spreading over about 500,000 sq ft. The plant manufactures and assembles intricate electromechanical equipment. We supply our own steam and softened water. And we have control of our electrical power from our own substation.

Production-wise, each department is responsible for its own operation. In contrast, the utilities are common to the entire plant and it would be difficult —and undesirable—to divide responsibility for maintenance of these items. Yet, many of the skills required for utilities maintenance are also common to production-equipment maintenance.

Should we have decentralized maintenance specialists for each production area and allow operating departments to keep their own maintenance records, programs, etc.? Or, should we have a completely centralized maintenance program for the entire plant? Is there a possible compromise?—*EEC*

2 Can I stop contact pitting with capacitors?

I'm having trouble with switch contacts and thermostat contacts burning and pitting. It happens on a 12-volt 40-watt dc clutch and on a 400-watt 230-volt 60-cycle ac strip heater. As a result I must frequently replace the contacts.

Can I improve contact life by connecting a capacitor in parallel across the contacts? How can I choose capacitor size?—*MT*

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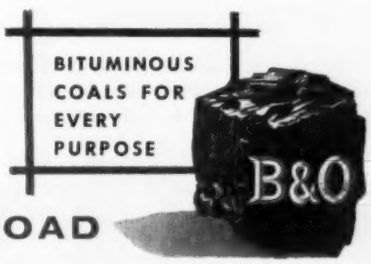


BALTIMORE & OHIO RAILROAD

ARGUMENTS . . . *let other readers know your views*

ALTHEA THORNTON, *Assistant Editor*

Is boiler metal burned? Here's what readers say . . .

Inspect, make hydrostatic test

Here's my reply to J Smitt's question about his locomotive-type boiler that suffered a low-water condition (*Arguments*, Nov 1956).

Since boiler was cherry red when Smitt observed it, the metal was probably subjected to about 1400 to 1700 F. Low-carbon steel begins to burn above the critical temperature of 1500 F, depending on carbon content. Boiler plates and tubes that have been overheated show a salmon or pink color upon being cooled. Burned boiler metal appears black or dark gray and is blistered from the surface oxidation and scaling as carbon unites with oxygen in combustion. Metal with the latter appearance should be carefully examined by first cleaning and then hammering to determine soundness.

Critical pressure parts should be trepanned or drilled to determine the amount of metal lost through oxidation. Tubes can be checked more readily by removing one tube selected as the most severely overheated, or as representative of the group. Cut sample in several pieces or section it for further careful examination.

Boiler is probably of riveted construction with staybolts, through stays and crown stays. The problem here is to hammer all stays to see that they are in proper tension. Next remove all insulation and apply a hydrostatic test of about 1½ times the design pressure. Observe all riveted joints, including the calking edges and rivets, for distortion or leakage.

As only a couple of tubes leaked at the joints and tubes were not bowed, I do not (from where I sit) think boiler was damaged severely. But undoubtedly some metal was lost to oxidation. My advice is to call in a boiler inspector. There may be other factors involved that would be detected by a man whose training has been devoted to such problems. One point he might pick up is whether any plates are warped.

This points up again the need for full-time attendance or at least scheduled checks for all boilers in service, whether or not they have automatic controls.

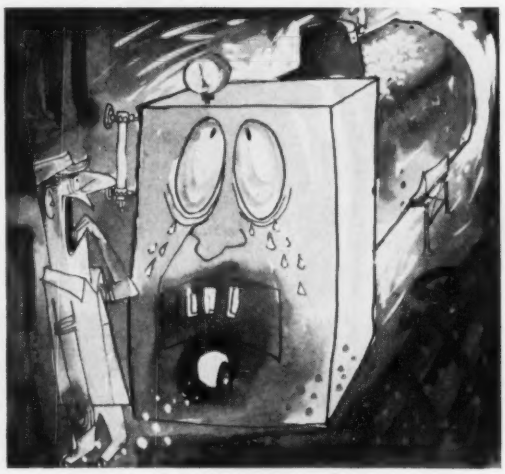
E C Cox, *York, Pa.*

Boiler is OK to operate

J Smitt's boiler is safe to operate. The parts that were cherry red were from 1400 to 1600 F. These parts were annealed at a higher temperature when the boiler was made.

Quick cooling might cause internal stress in the metal, but Smitt cooled the boiler slowly. Since the boiler parts are made of mild steel not subject to stresses easily, I would say boiler is safe to use.

HOWARD LADRACH, *Amherst, Ohio*



My advice to Smitt: Find another job

J Smitt does not say how the low-water fuel cutoff failed. Did actual failure of a float diaphragm or switch occur, or did it fail to operate because of stopped-up piping? How long did burner operate after the water became low? If, as he states, "things were really cooking around manhole and handhole openings," I assume boiler really took a beating.

He mentions this is a locomotive firebox. Crown sheet must have been uncovered. Smitt should have a boiler inspector determine whether the stays in the crown and side sheets may not have been stretched. Metal between stays generally has a tendency to bulge also. He should check this carefully.

If this is a high-pressure boiler, and I were the day operator, I believe I would be on my way to look for some other job, some distance away.

GEORGE KNUTH, *Appleton, Wis.*

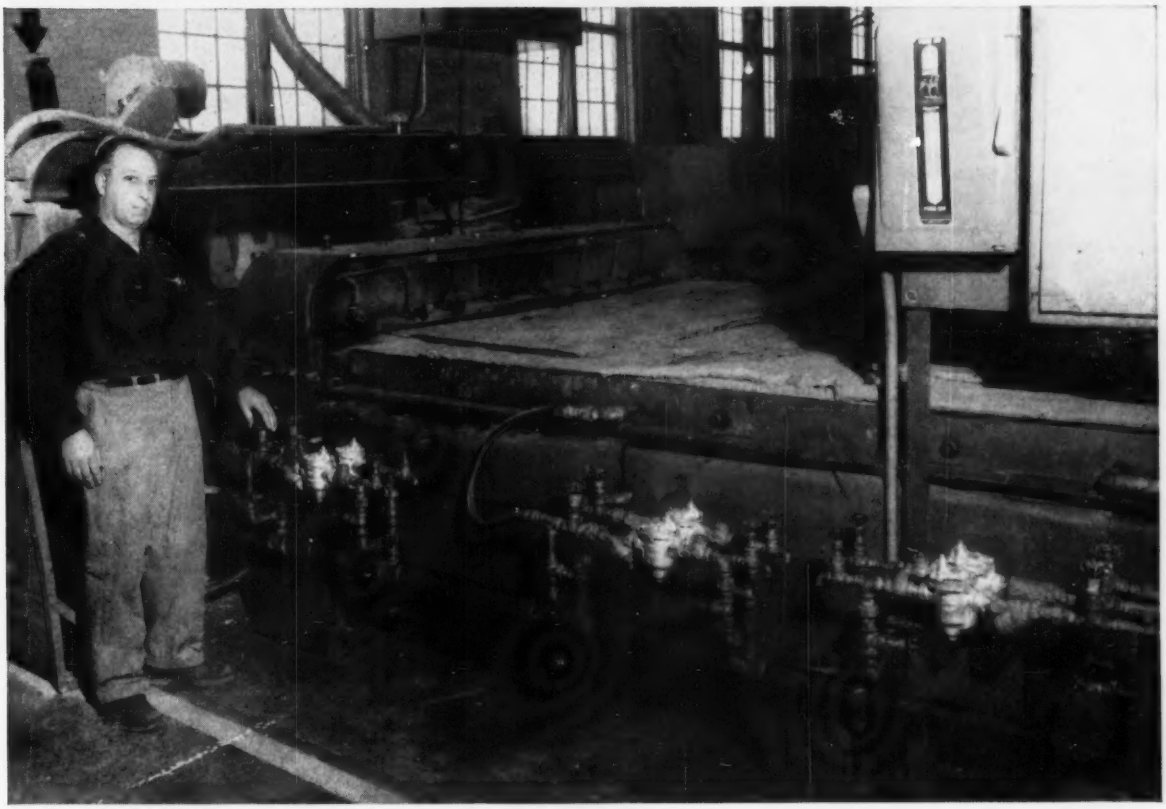
Call in the boiler inspector

I believe the damage from overheating Smitt's boiler was not serious. Before boiler plate would be seriously damaged, the tube ends would be so badly burned that tubes would have to be renewed to obtain tight joints. Mere rolling would not suffice.

If Smitt's boiler was welded construction, it was stress-relieved during manufacture at about 1200 F, depending on the material. Temperature was held at that value for one hour per inch of metal thickness. The description of the occurrence does not indicate heating comparable to this.

The above considers only possible damage from heating. Any damage from (*Continued on page* 214)

How to Get More Work Out of Steam Heated Equipment



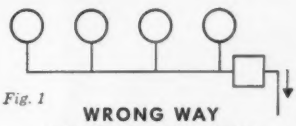


Fig. 1

WRONG WAY
"GROUP TRAPPING"

● One trap drains a group of steam condensing units. This causes "short-circuiting," entrainment of air, low and erratic temperatures. Ask for Bulletin 825 for complete details.

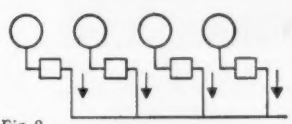


Fig. 2

RIGHT WAY
"UNIT TRAPPING"

● One trap drains *each* steam condensing unit. Condensate *and air* are removed as fast as they accumulate. This assures top temperatures and peak performance all the time.

Example: Armstrong "Unit Trapping" Increases Veneer Press Production 20%

If, anywhere in your plant, you have more than one steam heated machine—or coil, chest or roll of a machine—being drained by a single steam trap, give a listen to this:

Mr. Dominic Reali, plant engineer at the Stanley Company, Stanley, Wisconsin, was faced with glue joint failures on wood veneer coming off a platen press. The press was group trapped (Fig. 1) when he took over. Platen temperatures were erratic and production was inadequate.

What did Mr. Reali do? He called an Armstrong Representative to help him select a trap for *each* platen of the press. (Fig. 2)

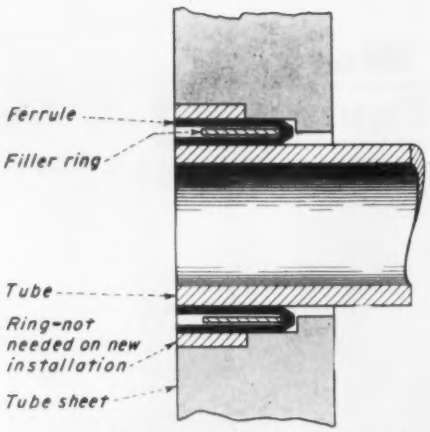
Now, press production is up 20% and glue joint failures are just a memory.

It doesn't matter whether you operate platen presses, jacketed kettles, unit heaters or what, the principle is the same. Armstrong *unit trapping* always makes equipment perform better.

GET COMPLETE DETAILS . . . Armstrong Bulletin No. 825, "Preventing Short Circuiting of Steam" tells the how and why of "group trapping" versus "unit trapping," explains what happens in steam condensing units. Free on request to your local Armstrong Representative, or:

ARMSTRONG MACHINE WORKS
8122 Maple Street • Three Rivers, Michigan

ARMSTRONG STEAM TRAPS



MOLDED-NEOPRENE SEAL expands into place, seals corrosive hydrochloric acid

HOW TO
stop corrosive fluids

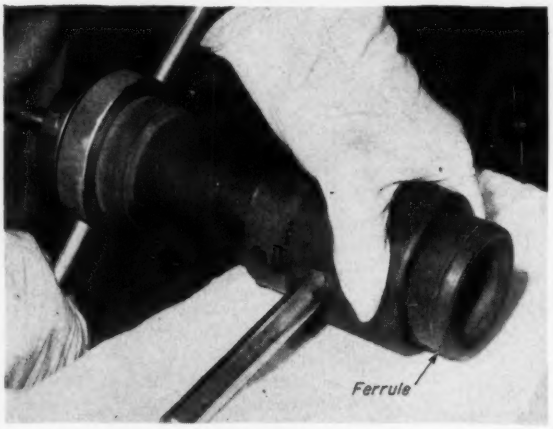
► LEAKY TUBE SHEETS in heat-transfer equipment handling corrosive liquids have always created a problem. Leaks even develop in costly materials and cause downtime, maintenance. Now problem is solved by a compounded-neoprene stock made into tube-sheet enclosures. At present neoprene is for low-pressure acid service, but may be adapted to higher pressures.

Molded-neoprene seal shown has filler ring made of same material as tube sheet. Special tool stretches the neoprene lengthwise, thinning down the inner and outer walls. This permits seal to pass over the end of exchanger tube. As seal is released from tool, it expands into the opening between tube's outer wall and tube-sheet hole. Expansion pressure creates a highly efficient seal, claimed to be comparable to a bolted-gasket joint. Yet no bolting or threading of any part is needed.

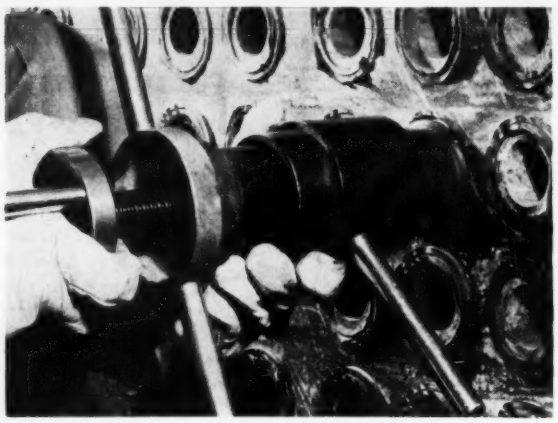
On a recent test, with seals at both ends of tube to balance end thrust, 400 psi caused no leakage. Tube sheet was reinforced for this test. When used as a plug, don't expect pressures above 10 psi to be sealed because of seal's tendency to roll out of hole. Besides resistance to hydrochloric acid, neoprene permits tube movement where most needed.

—Courtesy, E I du Pont de Nemours & Co.

1 Special tool is used to stretch neoprene ferrule. A one man operation, the tool makes retubing and sealing an easy job

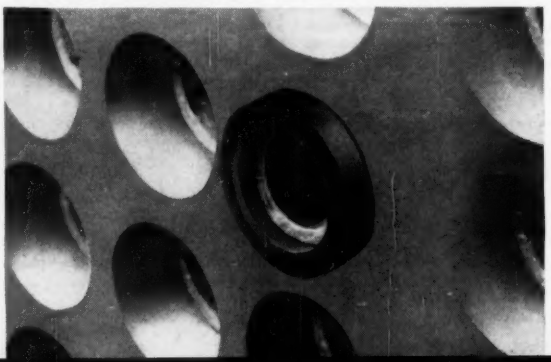


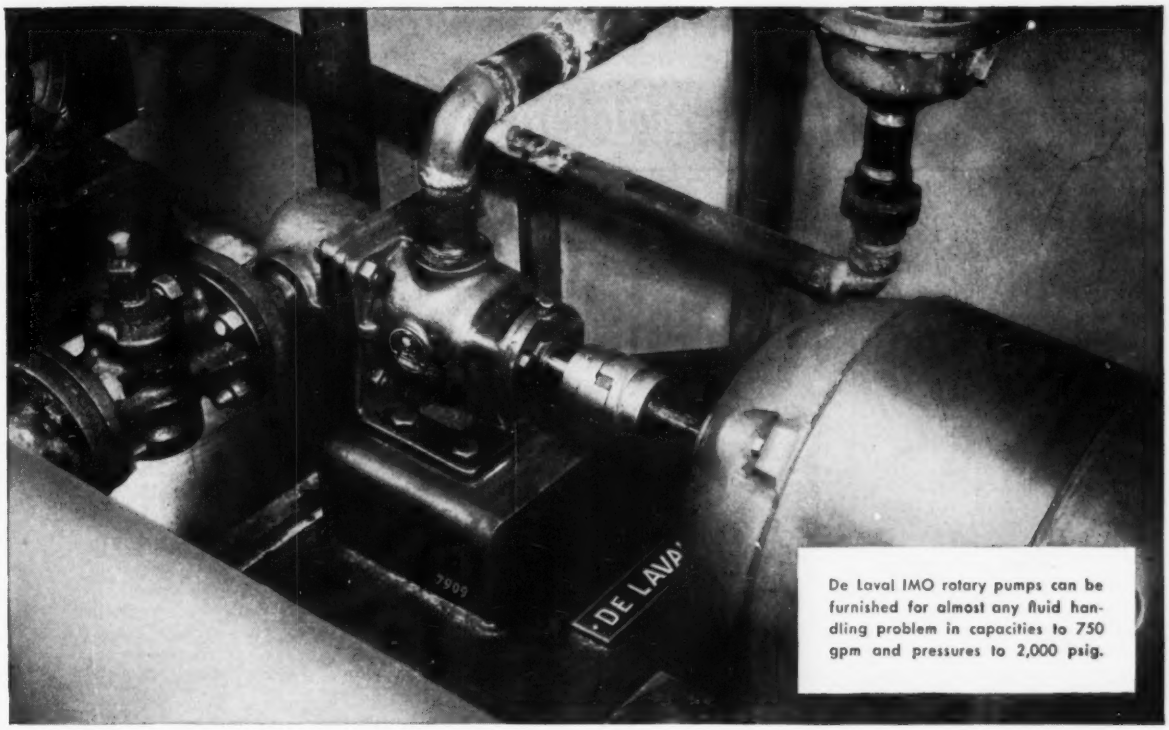
2 Place ferrule into tool as shown; tighten clamp up to knurled stop. Tightening stretches ferrule to right length



3 When ferrule is thin enough to fit in place easily, insert it into tube sheet, loosen clamp so it expands into place

4 Expanded neoprene ferrule (grommet) allows tube to move with expansion, without building stresses on the vessel





De Laval IMO rotary pumps can be furnished for almost any fluid handling problem in capacities to 750 gpm and pressures to 2,000 psig.

What to Look for in a Rotary Screw Type Pump

By W. J. MONGON, *Assistant Chief Engineer*
De Laval Steam Turbine Company

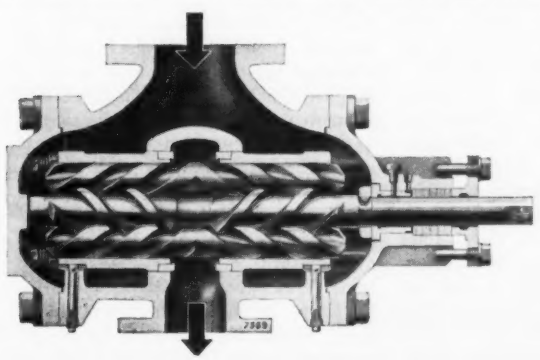
A sound knowledge of design, and how it affects performance, is the best insurance a buyer can have that he will get the pump he needs. This brief analysis of the IMO, a rotary three-screw pump manufactured by the De Laval Steam Turbine Company, will give you some of the necessary facts.

What qualities should you look for in a rotary type pump? It must, of course, meet specified capacities and pressures. But, it must also be efficient, operate quietly, stay on the job.

The axial flow of a screw type pump, and the resulting low inlet losses for any given pump speed, are important benefits that should be considered in making pump selections. The absence of timing gears and other mechanical features of construction also enable the De Laval IMO pump to operate at direct-connected motor and turbine speeds . . . to handle viscous liquids and high suction lifts.

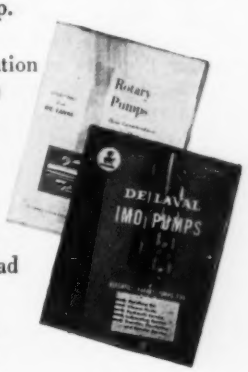
One of the most important features of the IMO pump is the hydraulic turning of the idler or sealing rotors. The central or power rotor is the pumping element; the liquid pumped turns the sealing rotors.

A screw type pump is well suited for applications where pulsation-free flow is desirable. The axial flow of the liquid without trapping and the unique thread form which keeps closures fluid-tight contribute to quiet operation of the IMO pump.



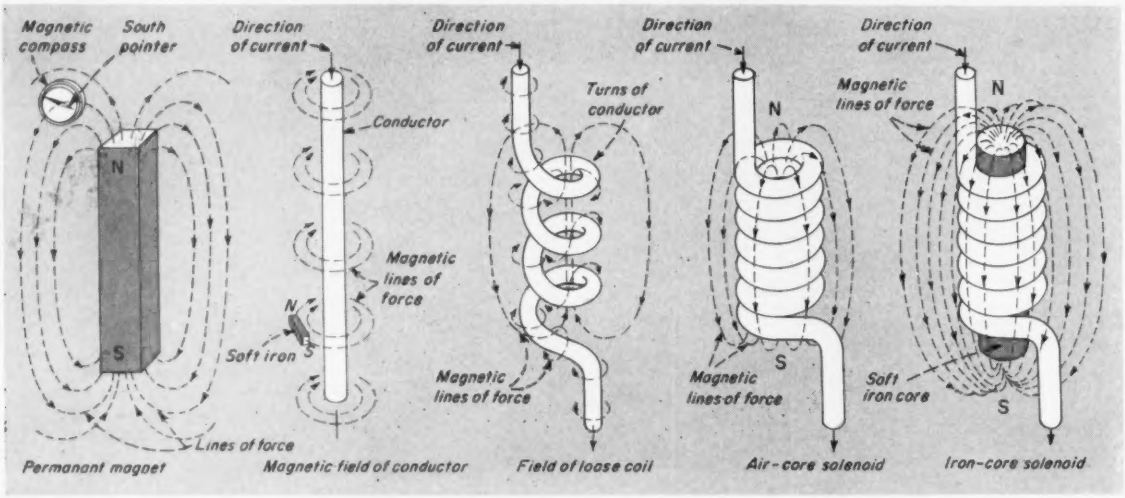
This is a cross-section of the De Laval IMO Series A322A, a positive displacement rotary screw type pump.

Catalog LS gives useful application and specification data on the IMO pump. An article titled, *Rotary Pumps, Basic Considerations in Their Application,* contains a description of rotary pumps in general. For these publications, write on your company letterhead to De Laval Steam Turbine Company, **815** Nottingham Way, **Trenton 2,** New Jersey. DL-301



BASICS . . . *bringing engineering theory down to earth*

NORMAN PEACH, *Assistant Editor*



MAGNETIC FIELDS about permanent magnet, single conductor and solenoid. When straight wire is twisted into loose coil, some of circular lines of force combine to form loops through whole coil. Field of solenoid takes shape of permanent magnet's

Electricity: 7

Electromagnetism

► ELECTRIC CURRENT always produces magnetism. Sometimes this magnetism is so weak it's not detected. Under other conditions it is intense. Magnetism produced by electric current, or *electromagnetism*, is the same as the magnetism of permanent magnets or of loadstone. However, since electromagnetism depends on electric current, it is easily controlled by regulating the current. What's more, electromagnetism can produce fields that are much stronger than are practical with permanent magnets. Electric generators and motors, magnetic contactors and relays, and lifting magnets are important applications of electromagnetism.

Permanent magnets and electromagnets exhibit a property known as *polarity*. If a light bar magnet is suspended so it turns freely, one end will point north, the other south. A magnetic compass is such a magnet provided with a card indicating north, east, south, west and intermediate points. Unlike poles attract while like poles repel each other. That is, a north-seeking (*N*) pole will attract a south-seeking (*S*) pole, but will repel another *N* pole. Polarity, and other magnetic phenomena, are explained on basis of magnetic *lines of force*. These lines of force are assumed to be distributed throughout the magnetic field in patterns that depend on the magnet's shape and nature of the material in the field. Some materials, especially iron and steel, conduct lines of force much better than air. If a piece of iron is placed in a magnetic field in air, lines of force will bend, or distort, in order to concentrate in the iron rather than air. Another very useful idea about lines of force is that they have a *direction*, or flow. Magnetism is said to flow out of a *N* pole and into a *S* pole. (This is an imaginary concept that doesn't involve actual flow of particles or energy, as current flow does. But it simplifies magnetic theory and calculations to such an extent that we're justified in assuming it.)

Magnetic circuits are studied by analogy, or comparison, with electric circuits. Lines of force, as units of magnetic *flux*, correspond to amperes as units of current. In order to produce magnetic flux, *magnetomotive force* (mmf) is required, the counterpart of emf in electric circuits. Similarly, magnetic circuits have *reluctance* where electric circuits have resistance. This leads to "Ohm's law of the magnetic circuit:"

$$\text{flux} = \frac{\text{mmf}}{\text{reluctance}}$$

Magnetism of electric current in a single conductor occurs as circular lines of force at right angles to the conductor. Sketch, above, shows only a few of these circular lines or rings. Magnetic field is uniform lengthwise along conductor. Field is strongest (greatest concentration of rings) near conductor, rapidly weakening as distance from conductor increases. If a small piece of unmagnetized iron is placed in magnetic field, some of lines of force will distort to pass through iron; *N* and *S* poles will be set up in the iron, indicating direction of the flux. From this we can derive the *right-hand rule:* Grasp the conductor with your right hand so your thumb extends along (*Continued on page* 194)

In JENKINS *Monel-seated Bronze Gates*

THE WEDGE TAKES THE WEAR - *and spares the rings*

Easy replacement of the wedge only — right on the line — restores full efficiency

THE MONEL SEAT RINGS are expanded into the body to assure a positive, leak-proof joint. Exhaustive tests in typical monel-seated gate valve services show that this permanent all-around support of the rings is essential to guard against deforming, loosening, or shifting.

***THE RENEWABLE WEDGE** (bronze or nickel alloy) has excellent wear resistance, but has a lower degree of hardness than the heat-treated Monel rings, which have optimum resistance to erosion and corrosion as well as abrasion. Thus, wear of the wedge leaves the rings relatively unaffected. When necessary to renew the wedge, you simply remove the valve bonnet, slip the old wedge off the stem, and slip on a new one.

GET PRACTICAL, LOW-COST RENEWABILITY in the valves you choose for the tough, punishing services that require Monel-seated gates. Compare . . . there is nothing simpler, faster, or more economical than Jenkins replaceable wedge design — and you also get the *plus* of Jenkins *extra value* in every other feature. Jenkins Bros., 100 Park Ave., New York 17, New York.

***MADE WITH BRONZE OR NICKEL ALLOY WEDGE**

The bronze wedge provides lasting economy for most applications. The nickel alloy wedge provides extra resistance where rapid wear and corrosion are factors.

JENKINS BRONZE GATES WITH MONEL SEAT RINGS

200 psi	300 psi
Fig. 270-U, Bronze Wedge	Fig. 280-U, Bronze Wedge
Fig. 270-UN, Nickel Alloy Wedge	Fig. 280-UN, Nickel Alloy Wedge
Fig. 270-UL, Bronze Wedge, U.L. approved for L.P.G. Services	350 psi
	Fig. 280-UX, Bronze Wedge

JENKINS BRONZE GATES INCLUDE 40 DIFFERENT PATTERNS

125 • 150 • 200 • 300 • 350 psi SOLID WEDGE • SPLIT WEDGE
SCREWED • FLANGED • SOLDER END • SOCKET END QUICK OPENING

Call your local Jenkins Valve Distributor for complete information.

JENKINS VALVES

LOOK FOR THE JENKINS DIAMOND

SINCE 1864 TRADE JENKINS MARK

Jenkins Bros

"Look at this souped-up technical double talk from that London consultant," raved Argyle L Wortheim to his foreman"

Marmy's dancing pumps

► "BILGEWATER on flying 6500 miles to Irubaak just to tame your vibrating pumps," roared Marmaduke Surfaceblow into his telephone. He puffed furiously on a piece of rope yarn, then continued. "I'll tell you what to do from my swivel chair in New York and it'll cost you only half as much."

I happened to be on the scene when the old boy made this boast last month. The dingy office over O'Houlihan's Machine Shop and Engine Works was unusually quiet. When the phone rang, Marmy's tough shipmates, seated along the settee, had stopped their wrangling. Sensing a big deal, they cocked an ear and slurped their coffee softly. I tried to muffle my coughing caused by the No. 6 Ringelman tobacco smoke that filled the room.

Before I go on maybe I'd better bring you readers up to date.

Earlier that day, I'd stopped in to visit the world-famous consulting engineer. He greeted me with the usual grunt and without adding a word, shoved a letter under my nose. It was airmail from Argyle L Wortheim, superintendent of the Khuuzistan Oil Co. His plant, located in Irubaak on the Persian Gulf, had a most unusual problem. These are the details:

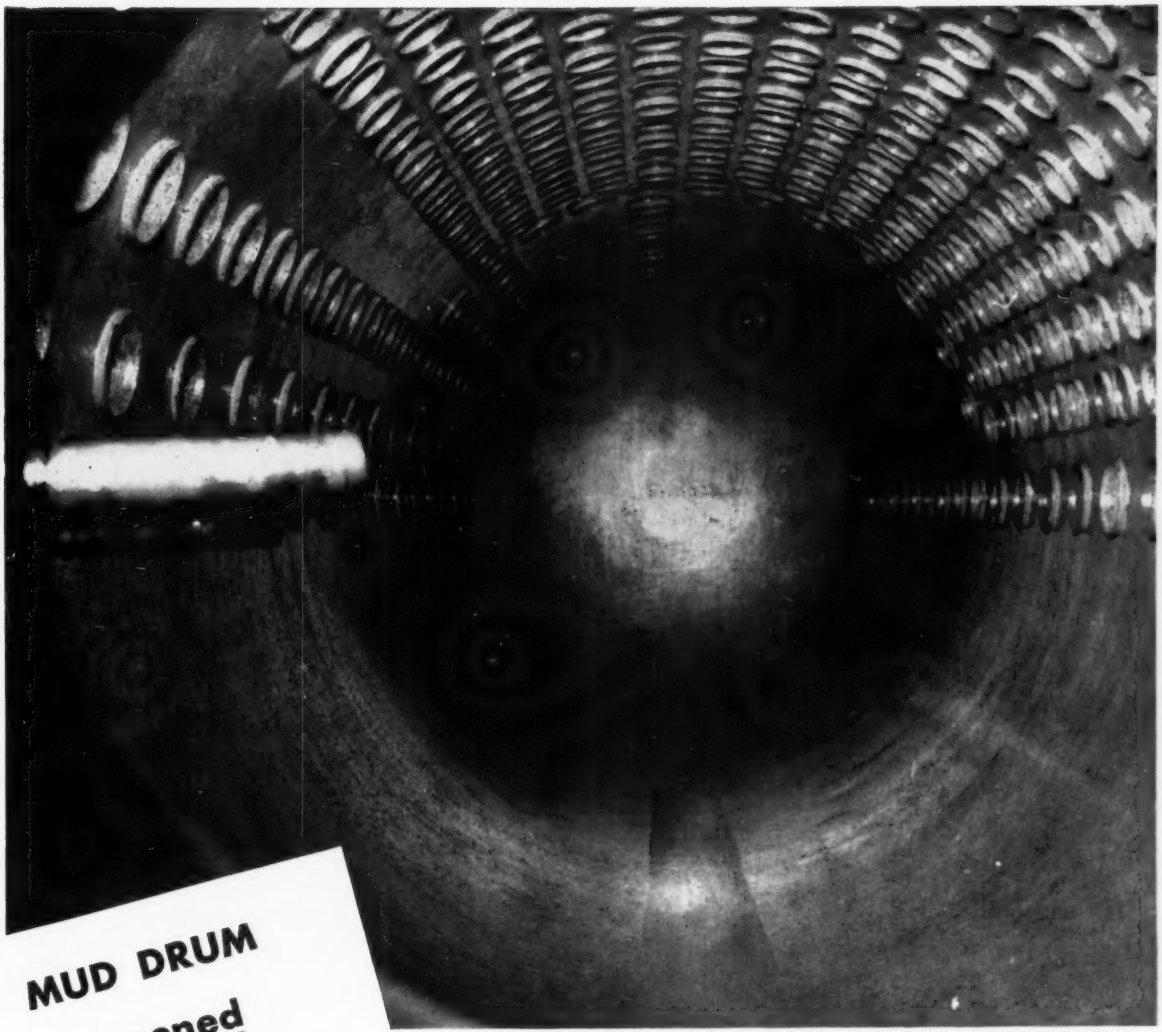
Two large transfer pumps were set up on a common concrete foundation in the firm's refinery yard at Irubaak. Both were the herringbone-gear type, motor driven; capacity of each was 5000 gpm at 150 psi. The two pumps were about 6-ft apart. Their 8-in. suction and discharge lines ran parallel for several hundred feet on either end; then the piping branched off to different sections of the large refinery. But the piping was connected and valved together before branching so either pump could handle the load. Fact is, one pump was always idle while the other was on stream.

One pump ran continuously for a month; then the other was put on stream while the first one rested. But there was something seriously wrong. Although the machines were only six months old, they were both shot. Each time operators started up the pump at rest they found its roller bearings false brinnelled. Seemed like the rollers had been pounded against their races with a sledge hammer, leaving long washboard grooves in the hardened races.

Added to that, the herringbone gear teeth were badly beaten up where they contacted each other during shutdown. Curiously, these things happened only to the idle pump.

It became standard practice to replace bearings in the idle pump before starting up. This was costly. Then after six months, the herringbone impellers of both pumps were so badly galled they had to be replaced. With good mechanics at a premium in that corner of the world and the refinery's production running at capacity, those dancing pumps had to be tamed.

Cause of trouble was obvious. Vibration from the running pump bounced the heavy double-helical rotors around in the idle pump like rubber balls. The rotors, in turn, damaged parts they contacted (*Continued on page* 196)



MUD DRUM as opened after one year on line with THE *nalco* SYSTEM

Unretouched photo of Nalco treated boiler at Georgia Institute of Technology, Atlanta, Georgia

Calling this a mud drum serves only to identify its location . . . it is perfectly clean after a full year on line. The unretouched photo was taken immediately after the drum was opened. No wash-out was necessary. Not only is the drum free of scale and corrosion . . . Nalco sludge conditioning operated so effectively that even under the static, off-line draining condition, no sludge deposited in tubes or drums.

The Nalco System can get results like these, economically, in *your* plant—regardless of boiler size or pressure. Write or phone Nalco today for action on a complete water treatment program.

NATIONAL ALUMINATE CORPORATION

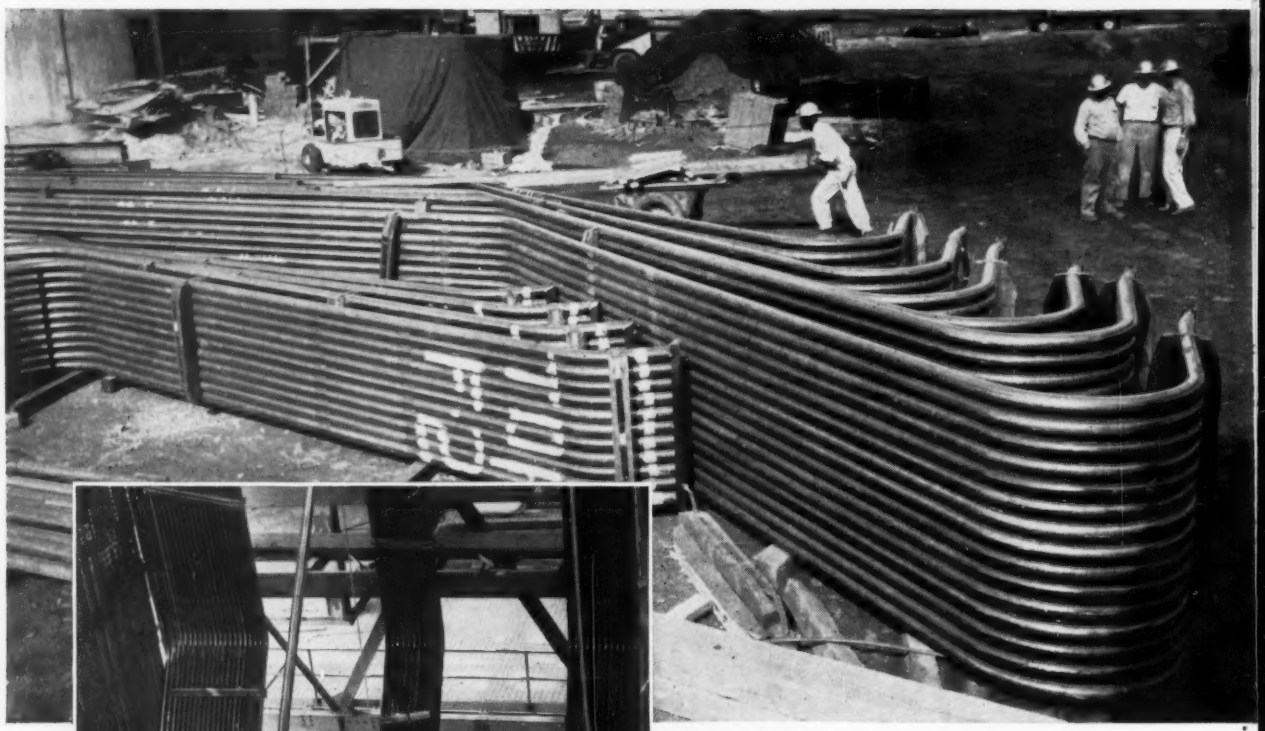
Telephone: POrtsmouth 7-7240

6222 West 66th Place • Chicago 38, Illinois

In Canada: Alchem Limited, Burlington, Ontario

THE *nalco*® SYSTEM . . . Serving Industry through Practical Applied Science

UNIFORM QUALITY of Republic speeds installation, assures top performance



SHOP ASSEMBLY into panel-type units saves time in handling transportation and erection. The uniform ductility of Republic ELECTRUNITE Tubing makes bending to a precise contour extremely easy. These units have been tack welded, shipped and are ready for final installation in boiler.

PANELS ARE RAISED INTO PLACE in huge, new Atlantic City boiler. Uniform concentricity of each Republic ELECTRUNITE Boiler Tube assures perfect fit in drum for easy rolling-in operation. Resulting joints are consistently tight and free of weepers.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

ELECTRUNITE Boiler Tubes in new unit

SPECIFICATIONS

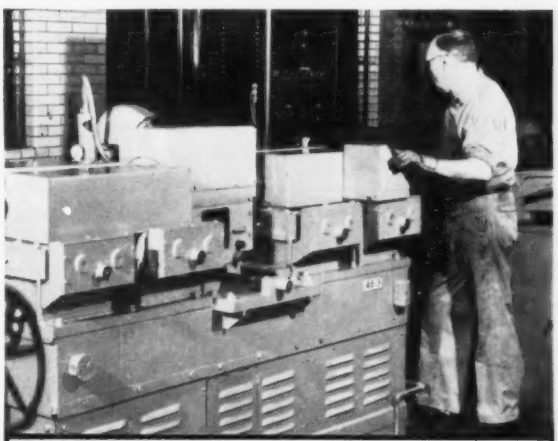
CAPACITY... 550,000 pounds of steam per hour
DESIGN PRESSURE . . . . . 1,475 PSI
OPERATING PRESSURE . . . . . 1,325 PSI
STEAM TEMPERATURE . . . . . 765°F.

This spring the Atlantic City Electric Company will substantially boost the kilowatt output in their Deepwater Station at Penns Grove, New Jersey. Now under construction is a large C-E Single Drum Radiant Type Steam Generator that will add 550,000 pounds of steam per hour to present capacity.

Combustion Engineering, Inc., New York, designers and builders of the unit, are using more than 125 tons of Republic ELECTRUNITE® Boiler Tubes. Previous good experience has proved that the uniform quality of ELECTRUNITE Tubing not only facilitates installation but assures top performance. ELECTRUNITE is approved on an equal basis with tubes made by any other process up to 850°F. and is available for pressures over 2000 PSI in various sizes and wall thicknesses.

The Republic ELECTRUNITE welding process produces a precise, uniform, wall thickness assuring uniform heat transfer all around and throughout the length of each tube. Dependability cannot be threatened by longitudinal thin spots. Uniform ductility permits smooth, accurate bending—plus full-expansion roll-in that assures tight, weeper-free joints. And each length of ELECTRUNITE Boiler Tube is hydrostatically or electronically tested to conform to the applicable ASTM specification and the requirements of the ASME Boiler and Pressure Vessel Code, as well as local, state and boiler insurance requirements.

Before you specify tubes for new or existing installations, get all the facts on ELECTRUNITE Boiler, Condenser and Heat Exchanger Tubes from your local Republic Representative. Or send coupon for literature. You will also find our wall chart entitled "Care and Maintenance of Boiler Tubing" a handy guide for protecting your present boiler installation. Send for it today.



SPECIFY FARROWTEST®

Here's the most conclusive, nondestructive electronic tubing test in use today. Developed by Republic, FARROWTEST provides detector coils that can electronically spot defects in tube walls which would be hidden from routine test procedures. You can specify FARROWTEST on ELECTRUNITE Boiler Tubes instead of your present method at no extra cost.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
Dept. C-3078
3144 East 45th Street, Cleveland 27, Ohio

Please send:
☐ Illustrated booklet giving facts on ELECTRUNITE Boiler Tubes
☐ 8-page brochure on ELECTRUNITE Heat Exchanger Tubing ☐ carbon steel ☐ stainless steel
☐ Handy wall chart on care and maintenance of boiler tubes
☐ FARROWTEST brochure

Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

Reader service section

Start with these quick samples...

Vacation with pay...

If your head is awhirl with technical problems and you feel the need for a rest, settle back for five or ten minutes with our news page. We promise it will be a profitable vacation and a pleasurable one to boot. This month, we have a feature story on the sharing of the St. Lawrence power pie that will interest you. For a change of pace . . .

Reports from the field, p 154

A little knowledge...

is better than none, in our estimation. With that idea in mind, we've taken the latest technical papers, pared them to the bone, and put them in a section all their own for your reading convenience. Of course, if you're of the school that says a little knowledge is a dangerous thing, we've provided directions for getting the full report.

Technical briefs, p 156

Wanna buy a duck?

If so, we're sorry but we can't help you. However, if it's equipment you're after, we've got something to fill the bill. It's a four-page roundup of the latest in plant machinery and accessories. The roster for this issue includes electrical equipment, boilers, pumps and valves. And if you're looking for a laugh there's a pretty good cartoon in . . .

Plant equipment news, p 160

Mad as a hatter...

That's what you'll be if you fail to acquire the manufacturers' bulletins we're offering. They're free and they're useful. For example, if you want specs and data on a certain piece of equipment, you can lay hands on it in a hurry simply by referring to one of these catalogs. So save your time, temper and money. Take us up on our . . .

Free literature, p 169

You can't win...

arguments and keep your friends unless you're willing to admit that there are two sides to every question. And we don't mean the right side and the wrong side. Perhaps there's only a grain of truth in your antagonist's position, but perhaps that grain is the very piece needed to complete the picture. Take time to find out. That's the advice of . . .

George Edwards, p 172

For other timely ideas, see following service pages ▶

New Revolutionary Steam Trap

One large capacity seat for all pressures!

New Sarco Thermodynamic steam trap. Sizes 3/8 to 1"... each body as small as a tee fitting! Capacity is determined, not by a bulky body, but by the effective orifice, valve action, pressure drop and condensate temperature.

1. Cuts trap inventory

With the revolutionary Sarco TD steam trap, you use exactly the same trap... with exactly the same large capacity seat... for all pressures 10-600 psi... for heavy, light or no condensate load. Sizes 3/8 to 1".

2. All pressures 10 to even 600 psi!

...without changes or adjustments. Self-adjusting. High pressure construction... at a low pressure trap price!

3. Operates perfectly when pressure fluctuates

Absolutely no effect even from 600 to 10 psi! No water seal to evaporate. No adjustments.

4. Widest capacity range

Same large capacity seat for 10 as for 600 psi. Pressures of incoming air and condensate INSTANTLY AND FULLY raises valve head (disc), permitting maximum discharge.

5. Operates equally well on all loads

The same Sarco TD trap for heavy, light or no condensate load. No prime to lose. No adjustments.

6. No oversizing worries

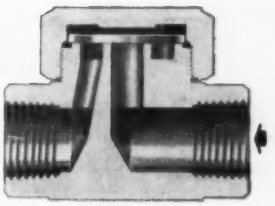
You can size the new Sarco TD steam trap for peak condensate loads... without risk of blowing steam on light loads... no prime to lose... no adjustments.

7. No steam leak required

...to operate the revolutionary Sarco TD steam trap (Pat. Pending). Closes tight against steam!

Convince yourself by 60-day trial... use coupon

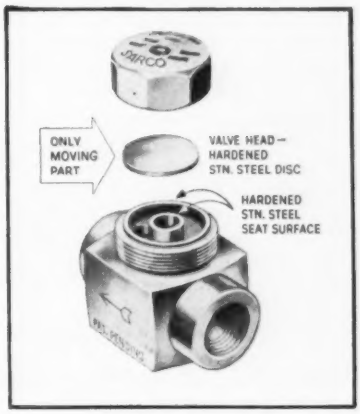
SARCO



Trouble-free design

Here is a trap so simple, it doesn't even have a valve closing mechanism. The kinetic energy of steam closes the valve. ONLY the new Sarco TD uses this operating principle.

No mechanism parts to wear or stick. No narrow channels to choke. No gaskets to leak.



Maintenance practically eliminated

The all-stainless steel Sarco TD has only 3 parts... cap, disc and body. Only moving part is a hardened SOLID stainless steel disc, practically wear-proof.

SARCO COMPANY, INC.
Empire State Bldg., N. Y. 1, N. Y.

Please send me Sarco TD Steam Trap and strainer for 60-day trial.
Size_____ For use on_____

Name_____

Firm_____

Address_____

City_____ State_____

2181-B

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 218

Reynolds Metals and Niagara-Mohawk bids for St. Lawrence power go to Governor

► As POWER WENT TO PRESS this month, officials of Reynolds Metals Co and Niagara-Mohawk Power Corp were still in doubt about getting a share of the power from the St. Lawrence project.

On Dec 27, following a public hearing, the proposed contracts were put before Governor Harriman. The governor has 60 days in which to approve or veto them.

Major labor unions, rural electric cooperatives, municipal power officials and the Liberal party in New York State are opposed to granting the contracts. They have joined in urging the governor to veto them.

Charges of "give-away" and "worse than Dixon Yates" were touched off in upstate New York by a 3-2 decision of the State Power Authority to sell Reynolds Metals a 239,000-kw share of St. Lawrence power.

The two dissident votes were cast by Former Gov. Charles Poletti and Thorne Hills, Harriman appointees on the authority. Mr Poletti and Mr Hills contended that the Reynolds contract violated the intention of the State Power Act of 1931 to give first call to domestic and rural consumers on state power production. They based their decision on an earlier award to the Aluminum Company of America. This first award, coupled with the Reynolds Metals contract, would comprise two-thirds of the power to be developed.

Mr Poletti and Mr Hills voted, too, against sale of 115,000 kw of power, plus all other power not used by other authority customers, to (*Continued on page* 216)

Power Lines

Not to be outdone, Hamilton Watch Co has come up with a device that puts Dick Tracy's wrist radio in the shade. Eliminating the mainspring, their electric wrist watch is powered by a battery no bigger than a shirt button.

Biggest valve order yet. Equipment valued over $1¼ million has been ordered from S Morgan Smith Co of York, Pa., by Pacific Gas & Electric Co of Calif. Order includes 13 valves and a turbine unit. Shipment scheduled for early summer of 1957.

Convinced that air conditioning business will continue to grow, Cloud Wampler, board chairman of Carrier Corp, reports his firm will expand to tune of $30 million over next 2-3 years. New facilities slated for Syracuse and West Coast.

Demonstrating President Eisenhower's atoms-for-peace program in action, a representative of the Netherland's ambassador has signed a contract with Babcock & Wilcox for fabrication of fuel elements for a swimming-pool type nuclear reactor.

Great Britain will produce more electricity with atom-fueled generating plants than anyone in the world by 1960. In the same period, the U.S. will lead in field of nuclear reactors for research and testing, according to study by Raytheon Mfg Co.

Scottish nuclear station to dwarf Calder Hall

London—(*McGraw-Hill World News*) Details of the first industrial nuclear power station announced by Britain's Central Electricity Authority and South of Scotland Electricity Board make Calder Hall look "ancient, crude and tiny."

The General Electric-Simon Carves group, awarded the Scottish station, makes use of a giant spherical reactor of double skin construction 70 ft diameter; raises coolant pressure to 150 psi; jumps steam conditions to 585 psi, 700 F.

Design is not only the most unconventional of the bids based on Calder Hall but also the cheapest and the largest. Installed capacity has gone up to 360 MW, with cost, per kw installed, of $300. Of the output, 320 mw will be available to the grid. A *Goliath* crane, spanning 200 ft between wheel tracks, capable of lifting 300 tons is to be built to straddle construction site.

Reactor design features a shell-within-a-shell system. This allows the use of steels best suited to operating conditions. The inner shell runs hot. The outer sphere runs cooler because of heat protection afforded by the inner shell. Correspondingly, the inner shell is made of temperature resistant steel—the outer shell from standard boiler plate.

Eight heat exchangers will be radially disposed in pairs around each reactor; each will have a 2200 hp blower.

Test tube universe

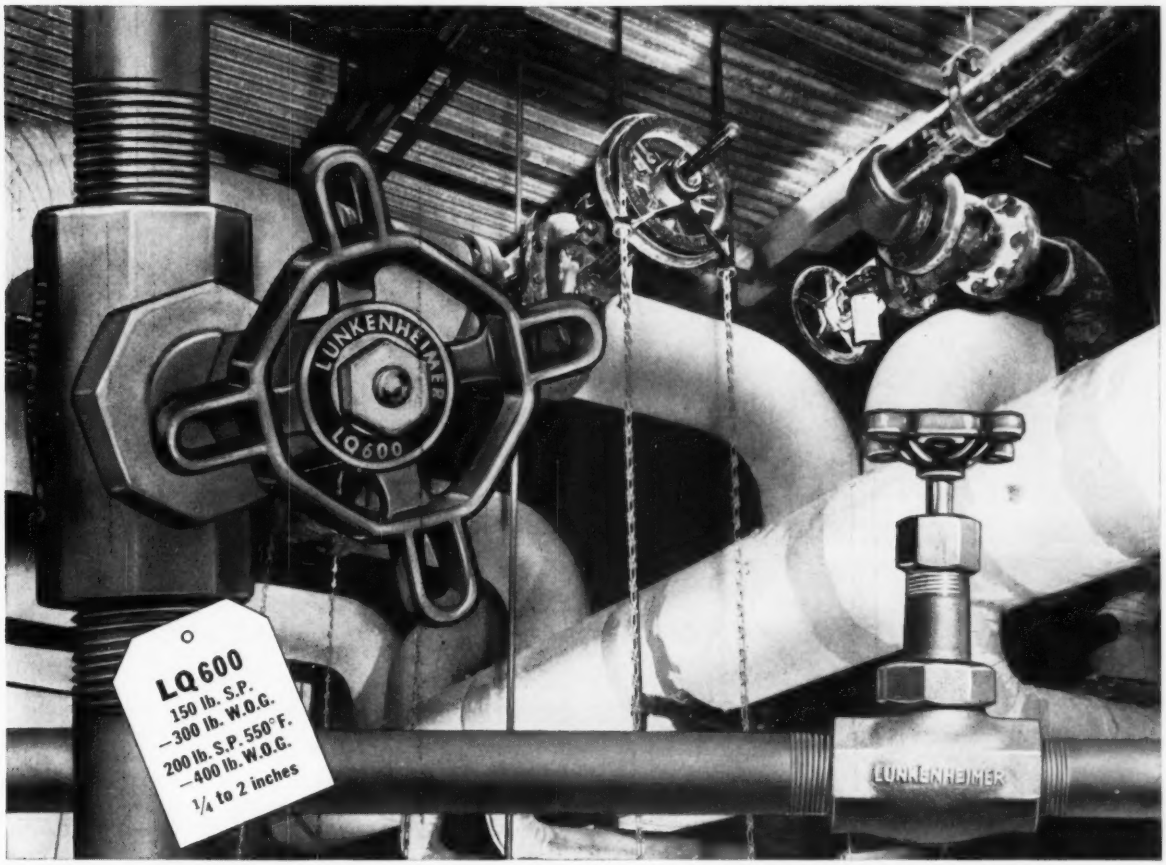
► USING A THIMBLE-SIZED atomic gun and a glass test tube, an atomic physicist has uncovered evidence for the possible origin of our infinite universe of stars and galaxies.

In tests conducted at Stevens Institute of Technology, electrified atomic particles, carrying both negative and positive charges, were shot out of the gun and subjected to a tremendous magnetic field. Miniature galaxies were formed, similar to those in our universe.

These findings, recently declassified, were revealed at a Washington, D.C. meeting of the American Nuclear Society by Dr Winston Bostick, conductor of the experiments.

Today, maintenance often costs more than the equipment itself!

You Can't Afford Less than the Best



What's happened to maintenance costs? That's a question you hear time and again in management-maintenance meetings these days. Costs are up sky-high and labor rates are still rising. The minute you touch a wrench to a valve, its cost can more than double! You can't do anything about the labor costs, but you can cut maintenance expense to rock-bottom by installing the one bronze globe valve that's handwheel-and-bonnet above all others . . . the LQ600, by Lunkenheimer. Thousands of these valves have served without maintenance for five years and more—many on the toughest throttling services industry can offer. The secret? Exclusive Brinalloy* seats and discs —harder than 500 Brinell Stainless! Insist on LQ600 Valves to help solve your number-one problem . . . sky-high maintenance expense. The Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.

The cost of a LUNKENHEIMER VALVE
Gets smaller... and smaller... *and smaller...*
with each passing year of dependable service

**Patented alloy—T.M. Reg.*

L-157-15

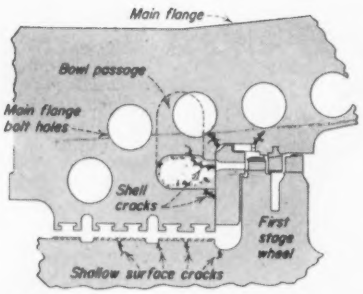
LUNKENHEIMER QUALITY

LUNKENHEIMER®
THE ONE *Great* NAME IN VALVES

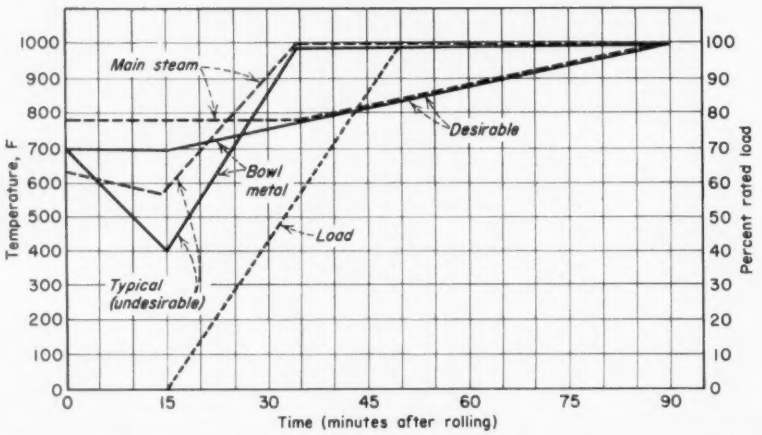
TECHNICAL BRIEFS

Latest engineering developments for busy power men

9 papers for you on
TURBINES
PUMPS
COOLING TOWERS
STATION FEATURES



AREA where major turbine cracks occur



TEMPERATURE relations between steam and turbine metal during starting, loading

Fast temperature changes can crack turbine shell

Importance of matching steam temperatures with metal temperatures during starting of large steam turbines. *By R L Jackson, S B Coulter, R Sheppard, General Electric Co.*

The best kind of operation for a steam turbine is to keep it continuously under constant load at constant steam pressure and temperature. But system load variations and present-day requirements call for daily starting and stopping of some units. This type of operation falls ususally on the older units built for lower pressures and temperatures. The industry is reaching the point where turbines subjected to this service are of the 1250 psig, 950 F or even 1450 psig, 1000 F level. This has caused some shell cracking.

The most critical areas of the turbine subject to thermal stress are in the hottest nonsymmetrical portions, primarily in the shell bowl passages feeding the first stage nozzle, sketch, above left. This area is subjected to the greatest and most rapid temperature changes.

The authors present recent test results and suggest design improvements to allow faster starting rates. They conclude that with proper temperature control and adequate instrumentation to insure against metal sections being subjected to excessive thermal stress, turbines can be brought to speed and fully loaded in times as short as 30 minutes after an 8-hr shutdown. Their present thinking is that temperature gradients across the turbine-metal walls should be limited to 150 F. Well-instrumented tests should be run on the boiler-turbine unit to determine optimum starting and loading conditions for each installation. *ASME paper No. 56-A-177.*

Directions for ordering papers on p 224

Pumps

An experimental study of centrifugal-pump impellers. *By A J Acosta, California Institute of Technology, and R D Bowerman, U.S. Industries Research and Development Corp.*

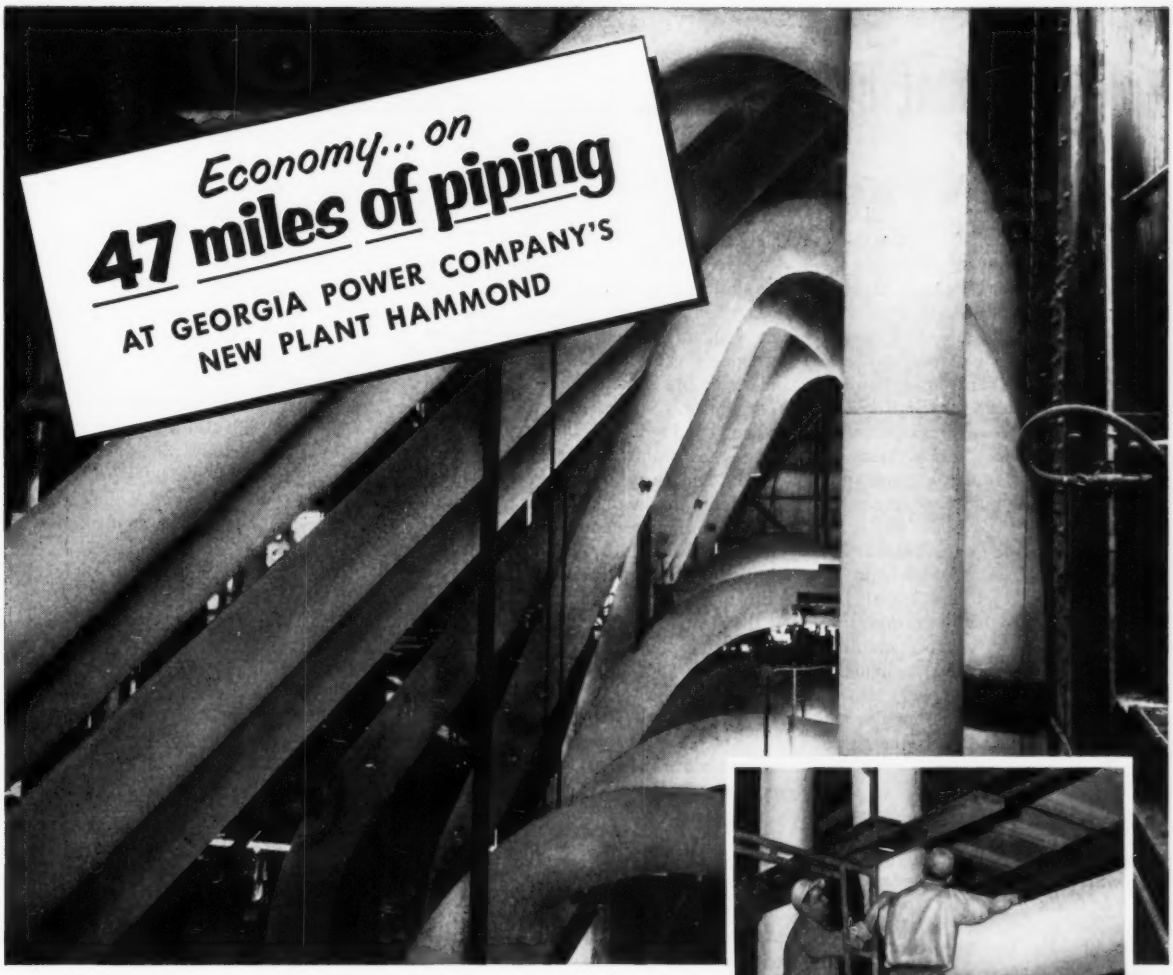
Experimental investigations were made on four two-dimensional impellers and on a well-designed commercial three-dimensional Francis impeller. The overall performance of each of these impellers was measured and internal-energy loss and pressure-distribution data were also obtained for several impellers. The exit angle of the two-dimensional impellers was fixed and the inlet angle was systematically varied. However, the hydraulic characteristics of these impellers were all found to differ, the source of the variation being in the various loss distributions and hence internal flow patterns in the impellers.

The two-dimensional and three-dimensional impeller-loss distributions were also different. The Francis-impeller performance agreed better with potential theory than that of the two-dimensional impellers, and it is concluded that the different loss distributions of the two types are responsible. *ASME paper, No. 56-A-41.*

Jet-pump theory and performance with fluids of high viscosity. *By R G Cunningham, Shell Oil Co.*

Performance characteristics of the jet pump when handling viscous oil have been established. Theoretical relations describing the jet pump are developed in this paper in terms of

(*Continued on page 158*)



47 miles of Johns-Manville 85% Magnesia Insulation boosts operating efficiency of Plant Hammond, one of the South's largest and most modern private utility installations.

Insulating feed water line at Plant Hammond. Contractor for this job was Brooks-Fisher Insulating Company of Atlanta, Georgia.

J-M 85% Magnesia Insulation helps cut fuel rate 25% below national average

Officials of the Georgia Power Company were gratified when the coal rate of their new Plant Hammond worked out at 0.75 lb. per KW HR, 25% below the national average. In their annual *Electrical Industry Statistics, Electrical World* had reported that increased efficiency in the techniques of power production has lowered the average coal rate to 1 lb. per KW HR. in 1954.

An important factor contributing to Plant Hammond's high efficiency was the selection of insulation. Johns-Manville's 85% Magnesia was applied in the most economical thicknesses throughout the plant for all piping and equipment operating in its temperature range. At higher temperatures 85% Magnesia was used in combination with J-M Superex® diatomaceous silica insulation.

This is only one of thousands of case histories where J-M 85% Magnesia has helped industry achieve outstanding fuel savings and increased operating efficiency. In all types of manufacturing and processing plants it is the standard for temperatures to 600F . . . providing high insulating value, easy application, long life, initial low cost and minimum maintenance. Write today for further information on J-M 85% Magnesia and Johns-Manville's complete drawing-board-to-job-site insulation service. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

Johns-Manville *first-in* **INSULATION**

MATERIALS · ENGINEERING · APPLICATION

More TECHNICAL BRIEFS

Begins on page 156

dimensionless ratios and friction coefficients. In addition, an energy analysis is made which separates friction losses and unavoidable mixing losses.

In an experimental program eight jet pumps, with nozzle-to-throat area ratios of 0.1 to 0.6, were operated over a range of jet Reynolds numbers from 700 to 30,000. Mineral and synthetic lubricating oils used covered a 5 to 100 centistoke viscosity range of the jet fluid. The results of these theoretical and experimental studies permit application of the jet pump to lubrication systems.

For design use the experimental data are reduced to friction coefficients and correlated versus jet and throat Reynolds numbers. To facilitate rapid estimates of viscosity effects, simplified empirical relations are also included. It is concluded from this study that the jet pump is indeed suitable for use with viscous fluids. *ASME paper, No. 56-A-58*

Cooling towers

Instrumenting a field study of industrial water-cooling tower performance. *By J L Willa and Technical Subcommittee No. 2, Cooling Tower Institute.*

The Cooling Tower Institute undertook a comprehensive investigation of the several factors influencing tower performance. In the hope of developing either corrections or compensations for the loss of capacity due to changes in atmospheric conditions, including wind velocity and direction, a thorough study was made to determine the exact cause and magnitude of the losses on various sizes, types and configurations of water-cooling towers.

Paper describes the instruments and other test apparatus used. The authors conclude that the instrumentation and methods used represent a distinct improvement over earlier procedures. *ASME paper, No. 56-A-22.*

Cooling towers for steam-electric stations—selection and performance experiences. *By M W Larinoff, Ebasco Services Inc.*

Cooling towers are an important element in the plans of tomorrow's steam-electric generating stations. Their outstanding advantage is the flexibility they offer to new plant locations. Their present short-comings, by comparison with experienced power-plant standards, are generally their short service life, high maintenance costs and thermal-performance deficiencies and losses.

The author presents maintenance cost data for 50 towers totaling 2,600,000 gpm capacity, and discusses the effect of tower thermal-performance deficiency on station capability and heat rate.

The answer to a dependable, durable and economic cooling tower may not be in today's redwood towers nor in an indestructible substitute-material tower, but it must lie somewhere in between.

The cooling-tower industry should solve the problems facing the purchasers and users today by establishing acceptable minimum standards of thermal performance and structural and mechanical durability. By doing so, the industry will prepare itself to successfully meet the expanding future needs of the electric utility industry and grow in an atmosphere of confidence. *ASME paper, No. 56-A-59.*

Station features

Salient electrical features of Muskingum River plant. *By V P Rader and C P Zimmerman, American Gas & Electric Service Corp.*

The Muskingum River Plant of the Ohio Power Company affords an excellent opportunity to review and reappraise past and present thinking with regard to the electrical features of a modern power plant on the American Gas and Electric system. Located in southeastern Ohio on a tributary of the Ohio River, it is strategically situated not only with respect to an abundant supply of high-quality coal, but also in relation to the concentrated load areas in the central and southern sections of the state.

The decision to construct this plant and a similar plant on the Kanawha River in West Virginia was contemporary with decisions to initiate construction of a 330-kv transmission system for delivery of large blocks of power from sources to large load centers, ultimately taking over this function from the existing 132-kv transmission system but performing it on a much larger scale. Consequently, the interconnection between these two plants was the first transmission line built for 330-kv operation. *AIEE paper No. 56-66.*

Design changes for unit 3, Meramec plant. *By R W Gaskins, Union Electric Co of Missouri.*

The original plans for Meramec were based upon the installation of four or five units approximately the size of the first two. Subsequent to starting construction of Meramec, substantial interconnections with other power systems were made, permitting the installation of generating capacity in much larger units without endangering the system upon loss of this unit. Ability to use larger units was demonstrated last year when the 280-mw generating capacity of Meramec was lost during maximum demand. Not only was no load dropped, but the voltage and frequency fluctuations on the system charts were hardly detectable. Therefore, when load forecasts indicated need for additional generating capacity and system studies placed this new capacity at Meramec, the company purchased a 287-mw maximum capability, cross compound axial-flow turbine generator for unit 3.

The installation of a unit twice the size originally contemplated creates structural and mechanical problems, as well as electrical problems. This paper describes briefly the salient features of design for units 1 and 2, reviews the merits of these features, and describes the changes in design planned for unit 3. *AIEE paper No. 56-770.*

Development of the electrical aspects in outdoor steam electric generating stations on the Pacific Gas and Electric Company system. *By Einar Nilsson, Pacific Gas & Electric Company.*

The basic assumption is made that the reliability of indoor and outdoor equipment is the same. The decision as to type is the result of a cost comparison between providing suitable space within the plant structure using indoor gear vs outdoor type gear. An outdoor feature will generally increase the price of a piece of equipment. However, to place the same piece of equipment indoors might make it necessary to provide building space, the cost of which is generally far in excess of the additional price due to weatherproofing. Other items such as temporary shelters used during overhauls and the increase in painting schedules due to weathering of outdoor equipment will increase maintenance cost, but this increase will be offset to some extent by cost of building maintenance of the indoor plant. Factors for and against the electrical equipment in outdoor plants as compared with its indoor counterparts are cited.

(*Continued on page* 224)

Directions for ordering papers on p 224

INCREASED PRODUCTION *with* GREATER FUEL ECONOMY

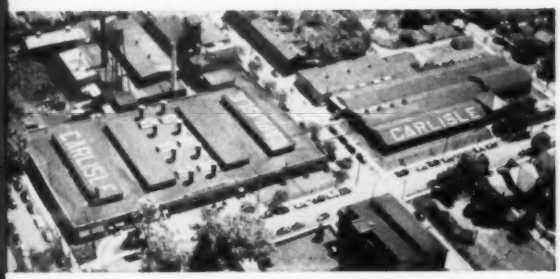
Smokeless Operation

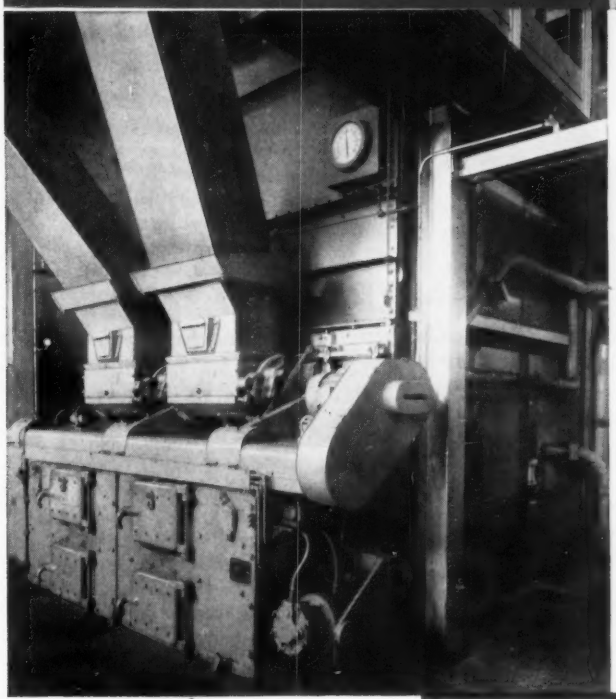
DETROIT ROTOSTOKER TYPE C-C

(Continuous Cleaning)

at Carlisle Tire and Rubber Division

CARLISLE, PA.





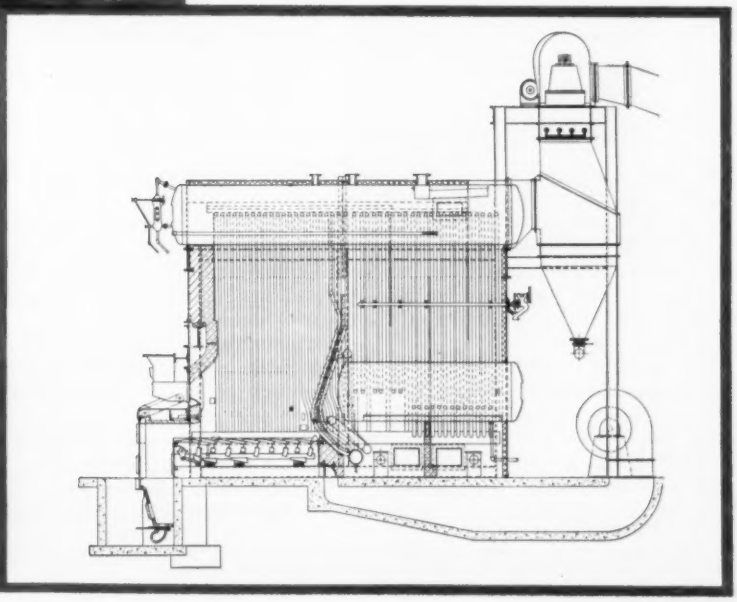
It is not uncommon for the Detroit RotoStoker, Type C-C to make fuel savings ranging from 10% to 25%. Where process steam is used in production, as in this plant, fuel economy is usually accompanied by a substantial production increase.

In addition the Type C-C provides smokeless operation at light loads as well as at full capacity—important in built-up areas.

Other advantages of Type C-C are:

- **Continuous uninterrupted steaming.**
- **Ample capacity and high availability.**
- **Quick response to load fluctuations.**
- **Fuel feeders and distributors handle high moisture coals without clogging.**
- **Available to develop 5,000 to 75,000 lbs. of steam per hour.**
- **Easily applied to new or existing boilers.**
- **Low Maintenance.**

Detroit RotoStoker Type C-C (continuous cleaning) in the plant of Carlisle Tire and Rubber Division of Carlisle Corporation. This unit has a capacity of 25,000 pounds of steam per hour. Either West Virginia or Pennsylvania 13,500 BTU coal is used.



Keeler Type CP Boiler with Detroit RotoStoker Type C-C. Ashes discharge at front, are removed by a conveyor. No basement is needed.

DETROIT STOKER COMPANY

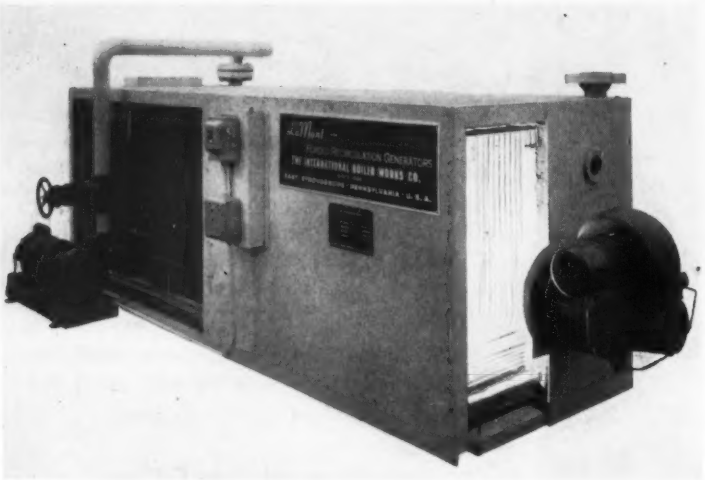
MAIN OFFICE AND WORKS
MONROE, MICHIGAN

District Offices or Representatives
in Principal Cities

PLANT EQUIPMENT NEWS

Your information center for new products designed to solve plant problems

Published monthly as a service to readers



Boiler anticipates new heating method

201 • Forced circulation boiler is suited for low- or high-pressure hot water heating. Manufacturer claims that unit makes temperature differentials of as much as 80 F practical for low-pressure systems. It is said to anticipate the trend towards higher temperatures and pressures for heating of single buildings.

Shown for the first time at the 1956 Power Show in New York's Coliseum, unit is a radical departure from traditional boiler design. It is said to incorporate the design features of larger generators in a low headroom boiler.

Among the design features is a counterflow economizer built into the steam generator. This is said to eliminate thermal shock which restricts allowable temperature differential between outlet and return water in boilers. Request full details from manufacturer.

International Boiler Works Co
Oak St, East Stroudsburg, Pa.

Noise reduced in boiler-feed-pump motor

202 • Boiler-feed-pump motor is designed for personnel comfort. Design is said to reduce operating noise considerably. High-frequency sound levels are reduced by sound-absorbing materials and baffling, while low-frequency sound is quieted through stiffening of stator frames.

Unit, available in 1000 hp and up, also includes features for reduced maintenance, easier inspection and longer motor life.

Inspection of bearings and stator windings is made easier by horizontally split cast iron end shields and air deflectors, and by use of a removable section and removable cover plates on either side of the motor near the base.

According to manufacturer, feeler gage openings provided at 90 degree intervals on the end shields make it easier to measure air gap.

Maintenance needs are said to be substantially reduced through use of a new bearing sealing system. Static air pressure is maintained on both sides of bearing to stop oil leakage. Details on request to manufacturer.

General Electric Company
Schenectady, 5, New York

Air release valves

203 • Heavy-duty air release valves are automatic and continuous in operation. According to manufacturer they release air as fast as it accumulates. Units are normally installed at high points of a piping system where air pockets naturally form.

Made of heavy-duty construction, valves are built to last the life of piping installation. Body and head are of cast iron metal. Inside, a rust-proof heavy-gage copper float actuates a valve and seat.

V D Anderson Company
1935 W 96th St, Cleveland, Ohio

Flow control plugs

204 • Spline plugs made of Tungsten Carbide in 25 interchangeable sizes provide predictable flow control in a formerly "impossible" low flow range.

Pilot plants and laboratories can now scale down their process to more manageable proportions according to manufacturer. It is also said that product quality in full scale processes can be improved by the more accurate measuring of minute flows. Body sizes available are ½, ¾ and 1 in. Request details.

Hammel-Dahl Company
175 Post Road, Providence 5, R.I.

Pneumatic industrial valves

205 • Pneumatically-operated industrial valves are available in two models: piston-operated throttling valve and diaphragm-operated two-position valve. Both are designed to handle such gases as air, helium, nitrogen and argon, at pressures to 10,000 psi.

Valves allow pressure drops as high as 6000 psi under flowing conditions. They work at temperatures from 40 below to 400 F. Wider temperature variations are available in special versions. Both valve types come in hand-operated models with the same body construction.

Minneapolis-Honeywell
Regulator Company
2954 4th Ave, S, Minneapolis, Minn.

For more data on these items, use post cards page 169. Identify your request with item number.

COOLING TOWER POWER

GOES HIGH HAT

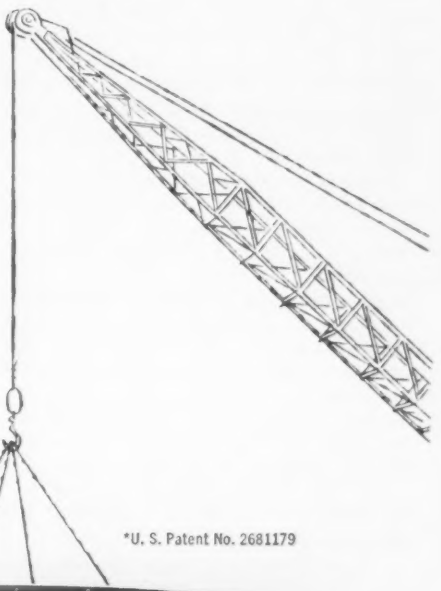
Putting the fan cylinder to work, making it a functional part of the tower, is Marley's latest achievement that brings a new look to industrial cooling towers. As an integral part of Marley tower power the new **VL** (vertically laminated) **Fan Cylinder*** has a job to do beyond merely discharging exhaust vapor at high elevation to minimize the hazard of fogging . . . IT AMPLIFIES FAN EFFICIENCY AND COOLING PERFORMANCE.

The distinctive **VL** contour is dictated by tested, scientific design that increases air volume by recovering velocity pressure . . . simply making more air do more cooling. To engineers specifying new equipment, this is an added and important assurance of Marley's ability to deliver full, testable performance on every cooling tower installation.

As modernization equipment for existing towers, **VL** fan cylinders positively reduce water cooling cost in any of three ways:

1. Cooling a greater volume of water at specified temperatures without added fan horsepower.
2. Cooling specified volume of water at specified heat load to lower temperature without added fan horsepower.
3. Reducing required horsepower for any specified performance.

VL fan cylinders are safe, sturdy units. Laminated construction provides a rugged design which assures long, trouble-free service. Bolted laminated bands and integral truss bracing result in a unitized packaged assembly independent of tower framework for structural stability. Safety to operating personnel is provided by the strength and height of the cylinder and by the large access door permissible only in **VL** design.



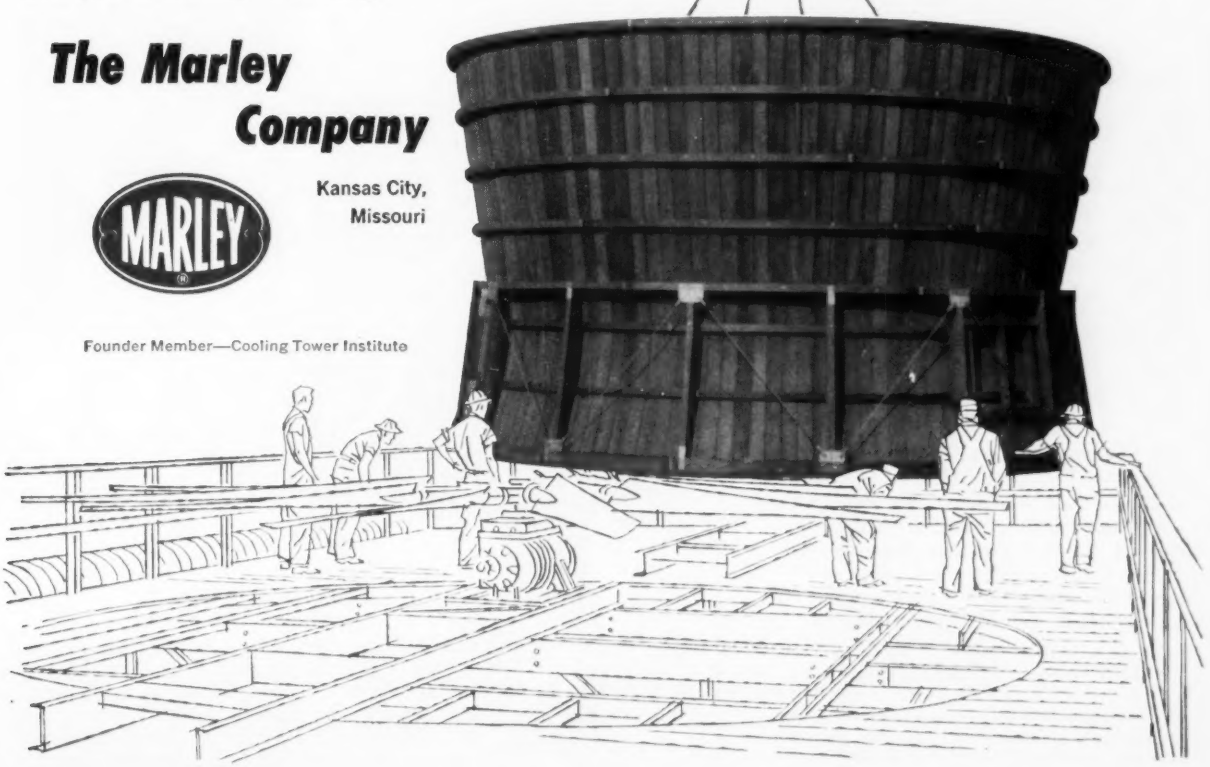
*U. S. Patent No. 2681179

The Marley Company

Kansas City, Missouri

MARLEY

Founder Member—Cooling Tower Institute



More EQUIPMENT NEWS

Begins on page 160

Will one of these five items fill your electrical needs?

Plastic tape makes insulation news

206 • Irradiated plastic insulating tape, *Irrathene*, is first commercial product of electron irradiation—the science of bombarding materials with high-velocity electrons to produce chemical changes.

It is being used now to insulate telephone and power cables, switchgear, small electronic coils, large motors and generators and other types of electrical apparatus. Manufacturer claims that its unique bonding and sealing qualities make it useful for coil encapsulation and wire harnessing.

Irrathene is a conventional polyethylene which has been bombarded by electrons traveling more than 600 million miles per hour. This knocks a few hydrogen atoms out of plastic's long-chain molecules and causes molecules to "lock arms," forming a new plastic that is tough, moisture resistant and chemically inert. Because of irradiation and added filler material, it is able to maintain its shape under high temperature conditions. Other advantages: ability to shrink-fit under high heat to contour of almost any object; high corona starting voltage and low corona intensity; excellent voltage endurance; high dielectric strength; and improved insulation resistance. According to the manufacturer, the tape can be applied around turns and bends without bunching, since it is highly flexible. Further information is available on request to the manufacturer.

General Electric Company, Schenectady 5, N.Y.

Silicon rectifier for continuous duty

207 • Silicon rectifier has forced air cooling with fan and silicon diodes shrouded to insure maximum air flow of 1000 fpm, ambient temperature 110 F. Dc output is 10 to 65 volts, 400-2000 amps. Regulation is $+-1\%$ automatic current for load and $+-5\%$ ac line change. Three units are used in parallel or series for higher voltage or current as required. Control is by saturable core reactor and high gain magnetic amplifiers. Unit measures 48 in. wide x 60 in. deep and 72 in. high. It is constructed of heavy angle enclosed with removable sheet steel panels. Request details from manufacturer.

Richardson-Allen Corp, 116-15 College Point, L. I., N.Y.

Brakemotors stop heavy loads fast

208 • Cast-iron brakemotors stop instantly and hold heavy loads. Features include a wide torque range from 3 lb-ft to 345 lb-ft, one-piece molded friction linings for quick stops, and one-operation torque setting. In event of power failure or low voltage, "dead man" operation sets and holds load until normal operation is restored. According to manufacturer, unit has few wearing parts and any adjustments may be performed with ordinary tools by removing brake housing and lifting out the entire operating mechanism. Further details on request.

Reliance Electric & Engineering Co.
1088 Ivanhoe Road, Cleveland 10, Ohio

Fractional hp motors

209 • Capacitor-start and split-phase motors, NEMA 48 frame size, come in rigid and resilient base models. According to manufacturer, weights of 1/6, ¼ and 1/3 hp ratings have been reduced from three to eight lb, making the new motors easier to handle and install. Lube system is effective in any position. Request details from manufacturer.

Wagner Electric Corporation
6400 Plymouth Ave, St. Louis 14, Mo.

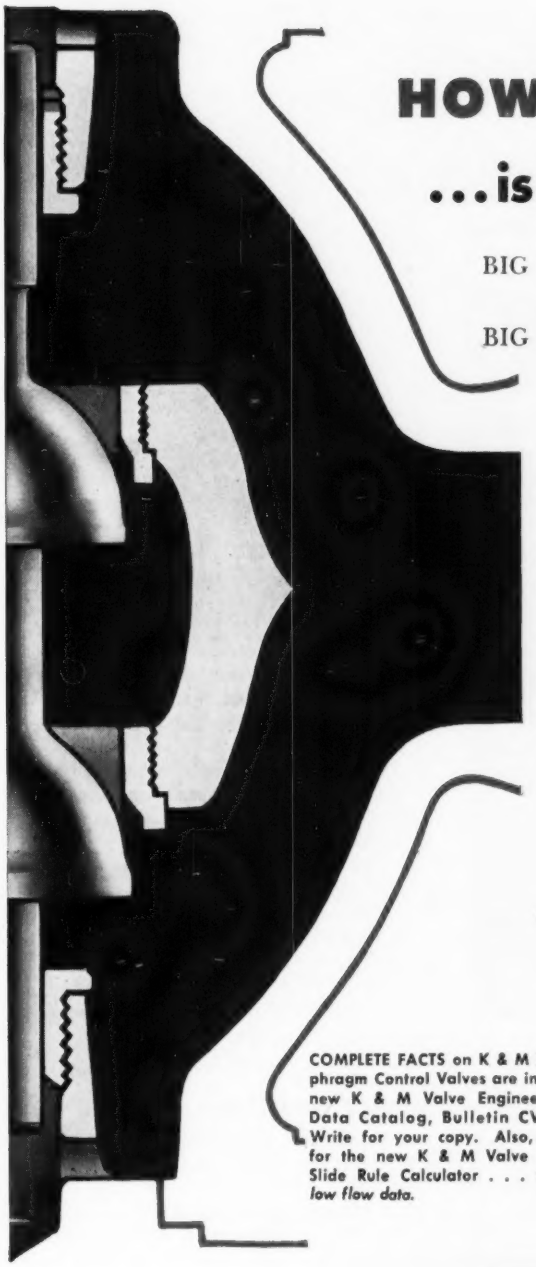
CT fault tester

210 • Instrument checks current transformer installations; pinpoints sources of possible trouble in short-circuiting, faulty connections, instrument tampering and grounding. Unit features spread of resistance burdens—.5, 1, 2 or 4 ohms. Lower burden values are recorded for testing small size low capacity current transformers. Details on request.

Walter S Chittick Co
1212 Chestnut St, Philadelphia, Pa.

For more data on these items, use handy post cards page 169. Identify your request with the item number.

"Hold it George. I think I've located the short."



HOW BIG

...is a K & M six-inch valve?

BIG enough to pass 500 gpm of cold water through the valve body at a constant drop of one pound pressure.

BIG enough to provide the largest flow coefficient available in a standard six-inch diaphragm control valve.

Body flow passages of all K & M valves, for example, actually average 140% of cross-sectional pipe area. There's more space for fluid to flow . . . smoothly, freely and without turbulence. Frequently a smaller nominal size K & M Valve provides sufficient capacity to satisfy requirements that formerly called for a larger, more expensive valve.

Inner valve open areas, on the other hand, average only 80% of cross-sectional pipe area. Therefore, flow restrictions occur principally across the inner valve . . . where the restriction is controllable throughout the entire range of valve stem travel.

This K & M design often permits lower initial costs . . . always contributes to more precise flow regulation through the K & M Inner Valve.

COMPLETE FACTS on K & M Diaphragm Control Valves are in the new K & M Valve Engineering Data Catalog, Bulletin CV53. Write for your copy. Also, ask for the new K & M Valve Size Slide Rule Calculator . . . with *low flow data.*

C_V COMPARISON TABLE

Valve Size	K & M	Valve B	Valve C
¾"	10.9	8.4	8
1"	17.3	14.9	12
1½"	39.1	33.2	28
2"	61	57	48
2½"	97.7	71.0	72
3"	150	116	100
4"	219	197	165
6"	500	364	360

Based on the maximum C_V at rated travel through the valve body. From manufacturers most recent slide rules or tables.

diaphragm control valves

K&M

Valve Makers Since 1879

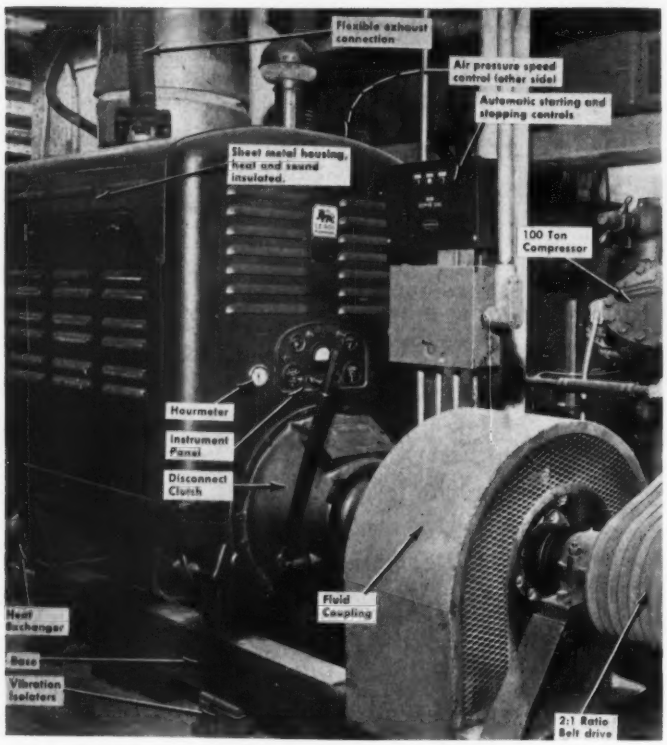
KIELEY & MUELLER, INC.

64 Genung Street
Middletown, New York

More EQUIPMENT NEWS

Begins on page 160

Natural gas-burning engines power air-conditioning equipment



211 • Natural gas-burning engines, such as the one in photo, left, are designed to provide low cost air conditioning. Engines are capable of powering 75 to 500-ton units and can be purchased in multiple units.

Manufacturer claims that initial installed cost is only slightly higher than that for electric motors and starting equipment. Maintenance costs are said to be higher for these engines, but it is claimed that savings in operating costs offset this difference. Engine fuel consumption is 10 to 12 cu ft per hphr.

Another advantage claimed for engine-powered air-conditioning equipment is that a well-designed engine installation can be made to operate at variable speeds, instead of an off-on operation.

With fully automatic starting equipment and speed controls, engines start on cooling demand, warm up, assume the load and vary capacity according to cooling requirements of 12½ to 100% of rated capacity. When cooling demand ceases, engines stop. According to manufacturer units can run unattended day or night.

Automatic controls include a starting and stopping system, a variable speed control system and safety controls for the engine's cooling and lubricating systems. Request details.

Le Roi Div, Westinghouse Air Brake Co
Milwaukee 1, Wisconsin

Propeller-type roof ventilator

212 • These ventilators have certified ratings and redesigned fan wheel. Wheel is said to produce optimum efficiency when operating within the type enclosure formed by a power roof-ventilator housing.

Units come in four models: upblast-type exhaust ventilator, hood-type exhaust ventilator, hood-type supply ventilator, and air-intake hood. All models feature heavy-gage welded steel construction. All surfaces are phosphatized for rust resistance and have a baked enamel finish. Each model is provided with a flanged base for easy curb mounting. The hood types are completely weatherproof.

The upblast-type exhaust ventilator is designed especially for exhausting corrosive, oil or grease-laden fumes. The hood-type exhaust ventilator offers low resistance to air flow. The hood-type supply ventilator is recommended for applications requiring supply air during summer months or where climate does not require the tempering of cold outdoor air. Air-intake hood is used with a centrifugal heating and ventilating unit which will provide tempered makeup air for winter supply problems.

American Blower Corporation, Detroit 32, Michigan

Close-coupled centrifugal pumps

213 • Pumps are suited for air-conditioning, booster, condensate and other services. Units are single-stage, enclosed-impeller type.

Since the motor and pump are a complete unit, installation is said to be quick and inexpensive. Bolt the unit down, connect piping, power, and the pump is ready to use. Manufacturer claims unit compactness allows it to fit easily into any layout where space is at a premium.

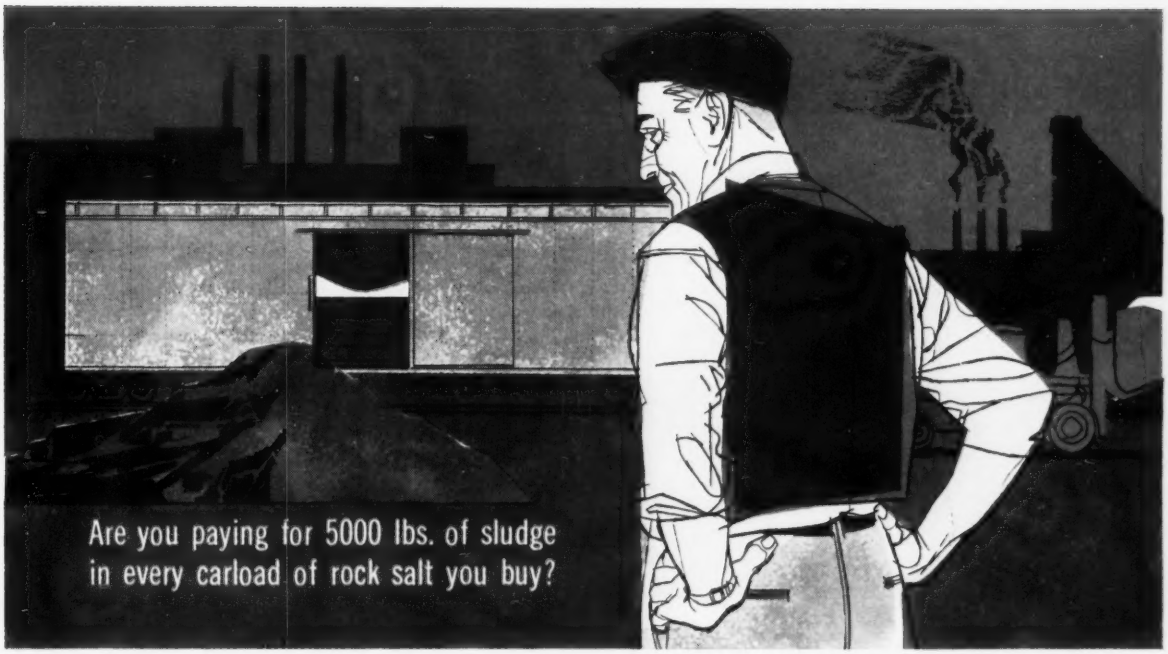
Close-coupled construction is said to assure permanent alignment of rotating parts and to give a safe, substantially built pump unit. No coupling is required.

Manufacturer states that once pump is primed, the mechanical seal is fully protected from running dry. Seal prevents leakage, does not bind the shaft or require any adjustment or periodic maintenance.

Discharge may be located in one of eight positions with drain, vent and priming openings provided. Maintenance is made easy by vertically split casing. Balanced impeller is only moving part so wear and noise are reduced. **Request bulletin 624 from the manufacturer.**

Goulds Pumps, Inc, 21 Black Brook Rd,
Seneca Falls, N. Y.

For more data on these items, use post cards page 169. Identify your request with item number.



Switch to sludge-free Purex Salt

In every 100 lbs. of rock salt you buy you assume the risk of paying for up to 5 lbs. of insolubles or sludge—shale and sulphates. This means that in a 50-ton carload of rock salt you may pay for as much as 5,000 lbs. of sludge! This insoluble matter is included in the purchase price of the rock salt and accounts for part of your freight bill. It also necessitates periodic cleaning out of your brine making system.

But when you buy Morton Purex Salt, you get high-purity evaporated salt that is made in a controlled particle size to prevent packing and channeling. With Purex, none of your purchase price or freight bill goes toward paying for insolubles or sludge.

With Purex, no time or labor is wasted in cleaning out insoluble matter from your brine making system to keep it functioning at peak capacity. For Purex is 100% soluble. Morton Purex Salt will leave no accumulation of material in either the brine or water softener tanks. It can be used in bulk wet storage systems and in the Morton Model E Brinemaker.

These filter pads (approximately 1/5 actual size) show you how much insoluble matter (sludge) you get in just 5 lbs. of various kinds of salt.

Southern Rock Salt | Northern Rock Salt

Kansas Rock Salt | Morton Purex Evaporated Salt

Tests for insolubles taken from these random samples show you that Morton Purex is the only one that contains no wasteful sludge, or insolubles.

For more information about Morton Purex Salt and for free, expert help on any water softening or brine making problem, write or wire:

MORTON SALT COMPANY

INDUSTRIAL DIVISION

Dept. P-2, 120 So. LaSalle Street, Chicago 3, Illinois

More EQUIPMENT NEWS

Begins on page 160

Electronic system finds boiler trouble spots

214 • Electronic system is said to analyze the operation of a giant steam generating unit in a few hours.

By sensing elements linked to analog scanners, system can probe hundreds of different boiler locations. At the touch of a button it begins gathering such data as temperature, pressure and gas composition. Electronic devices sort the information, supplement it with preset figures, and punch it in code on continuous tape.

Tape readings are transmitted from test site to New York by teletype where manufacturer has a large electronic computer. Translated into code suitable for computer use, information is processed mathematically and transmitted back to boiler site for application by engineers and technicians.

System has been developed to help engineers determine quickly and economically the source of boiler problems. Unit, developed and tested by Babcock & Wilcox and Bailey Meter Co, may be on the market soon.

Bailey Meter Company
1052 Ivanhoe Road, Cleveland 10, Ohio

Optimal controller

215 • Controller makes it possible to maintain optimum performance conditions automatically no matter what external conditions may change, according to manufacturer. It is said to be readily adaptable to a wide variety of systems.

Results are accomplished by using the slope of the operating curve of the process as the control parameter. By suitable choice of coordinates, slope will have dimensions such as pounds of steam per pound of fuel, for which there is some best attainable value. Unit holds this value in spite of changes.

Quarie Controllers, Canton, Mass

Safety gages

216 • Gages have been designed to provide maximum safety to the observer from possible bursting of bourdon tube because of excessive pressure, corrosion, or any other damaging or weakening factor. According to manufacturer, it also provides easy access to internal mechanism of gage for repairs, inspection, cleaning or recalibration. Available in 4½, 6, 8½-in. dial sizes.

Wexsler Thermometer Corp, Merrick Road & Buffalo Ave, Freeport, N.Y.

For more data on these items, use post cards page 169. Identify your request with item number.

Temperature regulator withstands corrosion

217 • Stainless steel unit is designed to withstand corrosive effects of certain fumes, gases, acids and chemicals.

Unit was developed mainly for use in chemical plants. Other applications seen for the regulator are in plating rooms and in processes where ammonia vapors are present. It is also recommended for exposed locations.

In standard models, the entire upperworks are of stainless steel. Company says that it will supply valves, as well as upperworks, for use in extremely corrosive situations.

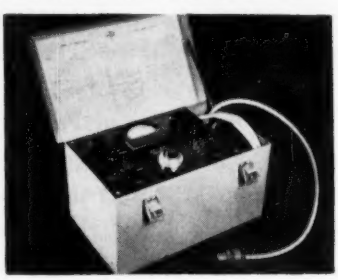
Robertshaw-Fulton Controls Co, Box 400, Knoxville, Tenn.

Moisture monitor measures minute quantities

218 • Portable moisture monitor measures minute quantities of moisture in gaseous mixtures. According to manufacturer, it is expected to solve many problems encountered in research, quality control and process efficiency. Its inherent versatility makes it useful in process and power applications. Output of the analyzer can be telemetered to a remote recorder for monitoring or control. Unit is 7½ in. wide, 6 in. high, 10 in. deep. Weighs 15 lb.

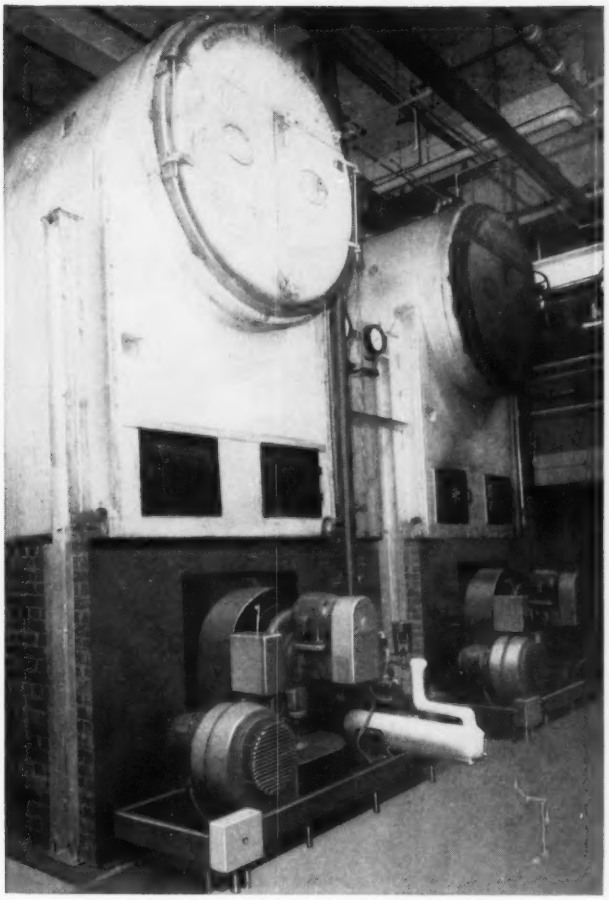
Consolidated Electrodynamics Corporation
300 North Sierra Madre Villa, Pasadena, Calif.

Be sure to check these items . . .



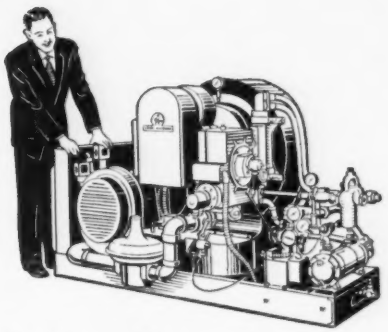
Meter measures corrosion . . . . . p 174

Flush raceway system . . . . . p 174
Flareless tube fitting . . . . . p 176
Torque-brake units . . . . . p 180
Packless expansion joints . . . . . p 180
High-capacity V-belt . . . . . p 184
Electric drill attachment . . . . . p 187
Power-system unit . . . . . p 187



Iron Fireman packaged oil firing units applied to firebox boilers. These units are suitable for nearly all types of steam or hot water boilers. The heating plant shown above is in the office building of the Celanese Corporation of America, Charlotte, N. C.

A complete firing system by Iron Fireman



Engineered as a unit . . . installed as a unit

For oil, gas or oil-gas combination

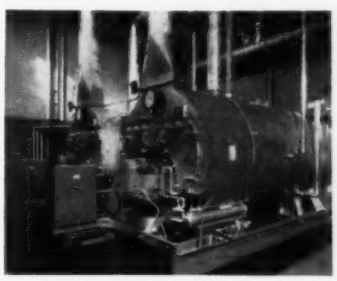
Here is a *factory engineered* firing system. Everything needed for balanced firing is mounted on a rigid steel base, ready to bolt to the boiler front. Nothing is left to the uncertainties of local assembly. For example, the critical refractory firing throat is pre-cast and installed at the factory, rather than being molded on the job. It is critical because proper design and accurate placement of the refractory tile increases combustion efficiency. It is scientifically designed to introduce secondary air around the burner head, avoiding the elaborate firebox brickwork in the typical conversion job.

Accurate control of all firing functions Every factor that affects firing efficiency is engineered into the unit at the factory. The unit includes: (1) Single or dual-fuel burner, with complete fuel handling systems. (2) Forced draft air supply. (3) Enclosed control panel, with instruments mounted, factory wired and tested, and with signal lights and dials that afford a complete reading at a glance.

In the oil-gas units, fuels can be switched automatically, or with the simple flick of a switch. Fires any fuel gas or any commercial grade of fuel oil available, including No. 6, without changing burner adjustment.

Local service. Hundreds of dependable Iron Fireman dealers are located in all parts of the United States and Canada. Their factory trained personnel are ready to furnish quick service to your burner, should the need arise. In addition, factory engineers are available in most areas to help you and your consulting engineer in planning boiler room modernization or construction.

For further information, mail coupon.



With matched Scotch type boiler

America's top boiler manufacturers join with Iron Fireman to produce boiler-burner units in which the boiler and firing system are engineered as a single integrated unit. Hundreds of these installations are in use in all parts of the world, with outstanding performance records. The boiler room, shown above, equipped with Iron Fireman-Kewanee units, is in one of the Detroit plants of the Briggs Manufacturing Company.

Iron Fireman®

AUTOMATIC FIRING EQUIPMENT FOR OIL, GAS, COAL

IRON FIREMAN MANUFACTURING CO.
3330 W. 106th Street, Cleveland 11, Ohio
(In Canada, 80 Ward Street, Toronto, Ont.)

Please send information on Iron Fireman forced draft firing for oil, gas, or oil-gas combination.

Name_____

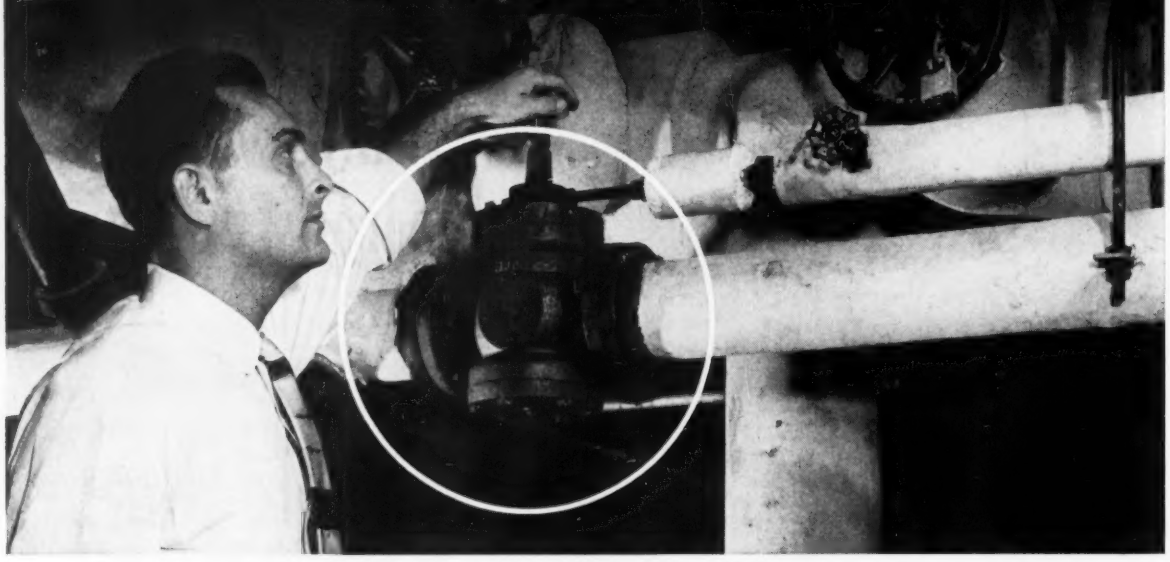
Firm_____

Address_____

City_____ State_____

PROVEN PERFORMANCE

at A. E. STALEY Mfg. Co.

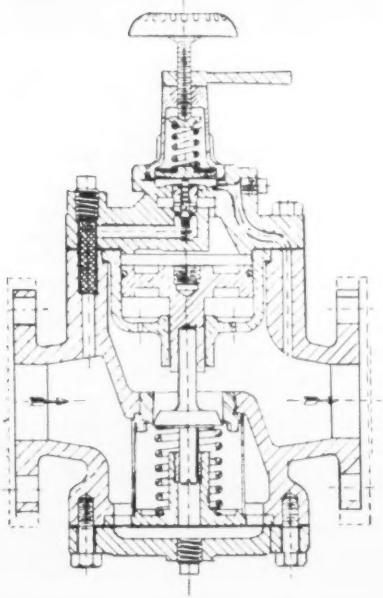


CASH STANDARD Type 44

Pressure Reducing and Regulating Valve for Steam Service

Sudden changes in the requirements for hot water in the employees' shower rooms at the **A. E. Staley** plant, Decatur, Ill., demand full capacity range operation of the regulating valve with precise control of downstream pressure.

In April of 1956, a CASH STANDARD Type 44 Steam Valve was installed in the line supplying steam to the heater. **Gerald Hammond,** instrument engineer at **Staley,** reports: "The CASH STANDARD Type 44 has given exceptionally good service—the kind of service we expect from all CASH STANDARD products. It has required no maintenance since installation eight months ago."



What's your control problem? Use this dependable steam valve.

Built in Pilot and Main Valve Strainers • Internal Pilot-Operated, Piston-Actuated • Single Seat • Highly Sensitive, Responsive to Smallest Changes in Reduced Pressure • Maximum Inlet Pressure 250 PSI @ 400°F. • Delivery Pressure 5-250 PSI • Available with External Sensing Line • Sizes 2", 2½", 3", 4".

For an individual solution to your control problem, contact the CASH STANDARD specialist in your area, or write Dept. E.

CASH C S **STANDARD**

A. W. Cash Co. and Its Subsidiary, Cash Standard Stacon Corp.
P. O. Box 551, Decatur, Ill.

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AIR CONDITIONING, VENTILATING

1 **Coil-surface type** air conditioners for industrial and commercial applications are described in 2-p bulletin 133. Contains photos and diagrams. Niagara Blower Company, 405 Lexington Ave, New York 17, N. Y.

2 **Centrifugal roof ventilator.** Illustrated bulletin SDA-220 discusses integral parts of unit, gives ratings, performance data. The Peerless Electric Company, Warren, Ohio.

★ **Centrifugal fans.** Illustrated 60-p bulletin C-103 features performance charts on line of backward-curved blade fans. Wheel diameters range from 13 7/32 to 168 in. ★Request direct, on company letterhead, to Chicago Blower Corp, 9863 Pacific Ave, Franklin Park, Ill.

3 **Dust control** for industry is title of 16-p illustrated bulletin 922. Encompassing complete range of dust-control equipment and accessories, the bulletin describes importance of dust control in relation to reduced maintenance costs, employee morale, commercial utilization of dust by-products. Contains a typical case history. Pangborn Corporation, Hagerstown, Md.

BOILERS AND AUXILIARIES

4 **Industrial oil burner,** said to effect a 30% saving in fuel costs by using heavy No. 5 oil, is described in 4-p bulletin ID-56-216. Industrial division, York-Shipley, Inc, 500 Jessop St, York, Pa.

5 **Fuel-burning system** described in bulletin 1231-A is a complete, packaged combustion assembly. It uses gas, oil or combination gas-oil firing for modernizing or converting existing boiler equipment, or for new equipment. Orr & Sembower, Inc, Reading, Pa.

6 **Refractory castables.** Illustrated 4-p bulletin R-40 describes use of Kaocrete-32—a high-temperature refractory castable—in boiler ashpits. Discusses various methods of ash removal. The Babcock & Wilcox Company, Refractories division, 161 E 42nd St, New York 17, N. Y.

COMPRESSORS AND ACCESSORIES

7 **Compressor,** adaptable to pressure or vacuum service, is described in 4-p illustrated bulletin B-154A. Contains selection charts giving blower model, brake hp and rpm needed to provide specified air-moving capacities in cfm at required pressures in psig or vacuums in inches of mercury. Read Standard Corp, 370 Lexington Ave, New York 17, N. Y.

(*Continued on page 226*)

result of an engineer's good common sense

Pre-fabrication saves time, space and money when B&W Seamless Welding Fittings are used!

The engineer on this job knows his business. He specified B&W Seamless Welding Fittings and arranged for pre-fabrication. Think of the time, space and money he's saving management.

And there's no question of the pre-fabricated sections fitting when they're ready to be installed, because they're dimensionally accurate. Full radius, true circularity and smooth walls of exact thickness permit fast alignment and easy fit-up.

This time, specify B&W Seamless Welding Fittings for a permanent, leakproof piping system. Seamless Welding Fittings allow piping to nest closer, are stronger, yet weigh considerably less than other types of fittings. They're available in a complete range of sizes and types in carbon and the B&W Croloys.

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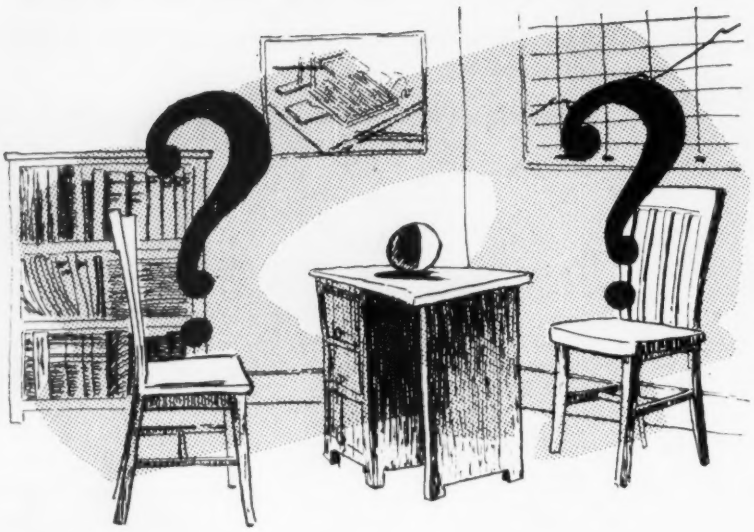
Seamless welding fittings and forged steel flanges, seamless and welded tubular products — in carbon, alloy and stainless steels.



George Edwards

says a lot depends on where you sit

► ON A TRAIN a couple of months ago, a pleasant-faced young fellow sat down opposite me in the diner. We talked about odds-and-ends as strangers do in such situations. I was getting ready to finish my coffee and leave when two men across the aisle got up from their table.

"I've got ten bucks that says you're wrong," one snarled. "It's gonna be done my way or not at all."

"OK," replied the other, "It's a bet. But it'll be like taking candy from a baby. Soon as we get to Cleveland, I'll prove it to you."

As they moved away my companion said, "I'd be willing to bet that the guy that wins the money wins himself an enemy with it."

"You're probably right," I agreed. "Brings to mind an old saying about 'a man convinced against his will.'"

"True," he said, "but the smart thing is to have the other fellow convince himself of how wrong he can be. I saw it done once and will never forget it."

"Sounds like a pretty good trick," I said, "but how does it work?"

"About four years ago," he replied, "two men, who we'll call Steve and Bob, worked in a shop in St. Louis. Steve was a production foreman and Bob headed up the inspection department. Both were smart and ambitious, and every so often they would lock horns. Neither would give an inch. Each was convinced that he was right—period!

"Joe Burke, plant manager, invariably had to step in and break the deadlock. He wasn't happy about it since he felt that if they could appreciate some of each other's problems they'd make a good team instead of circling like a couple of pit bulls.

"One day, Joe asked them to come to his office. They were seated in chairs facing each other. Between them was a small table on which was a cardboard carton turned upside down. Joe lifted the box revealing a rubber ball.

"Joe asked Steve what color the ball was. Steve said it was white. Turning to Bob, Joe asked him what color he thought it was. Bob said it looked black to him.

"Then Joe turned the ball around. Half was painted white, half black. 'Who's right?', he said, 'I asked you fellows to tell me the color of the *ball*, not just what color you *saw*. Neither of you gave a thought to the other side.'"

My young friend laid his napkin on the table and rose to leave.

"It didn't solve everything, of course," he said. "But it made a big change in the way they worked together from then on."

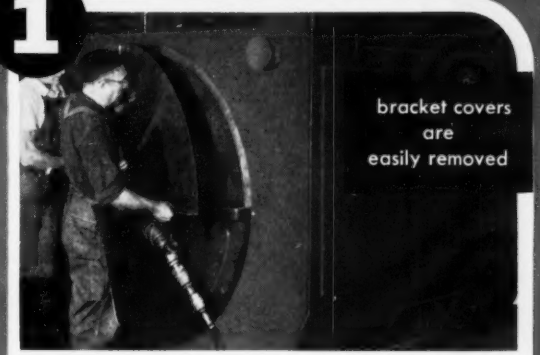
He grinned at me and added, "I don't mind telling you that I'm Bob, and I know now that a lot depends on where you sit."

EASY AS 1...2...3

to service this 5000-hp, 2-pole motor

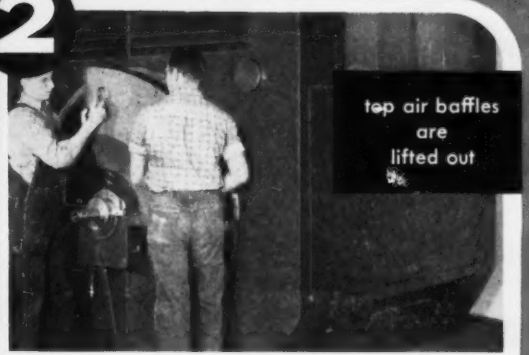
Elliott design speeds and simplifies maintenance

1



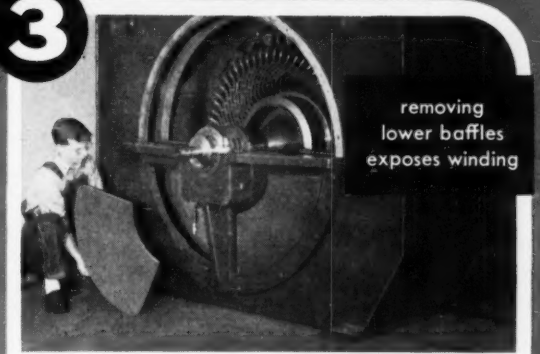
Maintenance procedure begins with removal of top bracket covers. Two men, without hoist or chain block, can handle the heaviest parts involved.

2



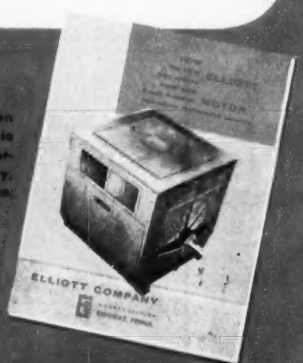
Inner air baffle is in four sections. Two upper sections are easily lifted through opening above lower half bearing bracket.

3



Covers on lower bracket give access to lower air baffles which are rotated into position above shaft, lifted out.

For more complete details on the maintenance of large 2-pole motors, see your Elliott representative or write Elliott Company, Ridgway Division, Ridgway, Pa. Ask for Reprint 64.



The ease of access illustrated here is typical of Elliott advanced designs for customers' special requirements. Upper and lower bearing sleeves are equally accessible. Actually, this motor is easier to service than most competitive machines *one-twentieth* its rating.

ELLIOTT Company

Ridgway Division, RIDGWAY, PENNA.

R 7-4

YOURS FOR MOST ANY GATE VALVE SERVICE

...The advantages of DARLING fully revolving disc design!

Darling Victaulic end gate valves are made in accordance with specifications to fit standard Victaulic couplings... just one of the many various types of ends offered by Darling to meet your specific installation requirements.

THE Darling *fully revolving, double disc, parallel seat* principle simplifies gate valve operation and cuts maintenance and replacement costs.

Darling offers this type of gate valve in sizes and alloys for practically any service you can name.

Regularly available in iron body, cast steel, rubber lined iron body, all bronze and special alloys . . . for ordinary and unusual services. Made with various type ends to meet your particular installation needs.

Write for complete information on Darling Gate Valves . . . the valves that give you the most dependable, maintenance-free valve service you've *ever* had.

DARLING VALVE & MANUFACTURING CO.
Williamsport 8, Pa.

Manufactured in Canada by
Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

DARLING
TRADE DARLING MARK
VALVES

More EQUIPMENT NEWS

Begins on page 160

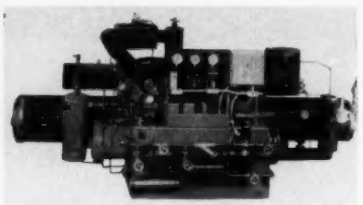
Meter measures corrosion

235 • Meter measures the progress of corrosive system electrically. It is used in conjunction with special probes containing metal specimens that are subject to corrosion. Probes of more than 30 metals and alloys are available. These are supplied in a number of designs to meet varying pressure and temperature conditions of different systems.

According to manufacturer, meter is able to make rapid and direct measurements with only about 30 seconds required for reading. No shutdown is needed to retrieve metals specimens inasmuch as the probe remains in the corrosive system at all times. Time to establish corrosion rates is measured in hours or days rather than weeks or months because of high sensitivity of measurement. With most sensitive probes, 1/10 of a microinch of corrosion can be detected. Measurements can be made in systems not easily accessible because several hundred ft of cable can be used between probe location and meter.

Crest Instrument Co, 11808 S Bloomfield Ave, Santa Fe Springs, Calif.

For more details on these items, use post cards p 169. Identify your request with item number.



Packaged liquid coolers

232 • Coolers employing flooded refrigeration principle, are of special multi-pass design. Units are suited for handling viscuous or slurry-type liquids.

Package includes a complete refrigeration cycle, compressor, motor and starter, refrigerant controls, liquid cooler, condenser, piping, wiring and insulation, shop-assembled and tested, ready for quick installation and immediate operation. Units are available in a range of sizes from 5 to 100 hp. Details from manufacturer.

Doyle and Roth Mfg Co, Inc
136-50 24th St, Brooklyn 32, N. Y.

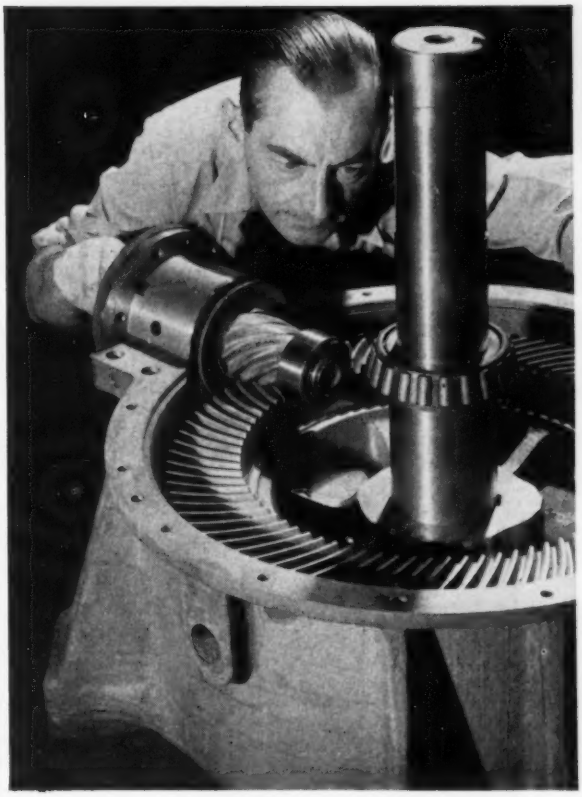
Flush raceway system

227 • System is used primarily for modernizing existing buildings. It is installed

7 REASONS WHY

COOLING TOWERS EQUIPPED WITH FLUOR-WESTERN GEARS GIVE LONGER LIFE WITH LOWER MAINTENANCE COST

1. **A CONSERVATIVE MATERIALS FACTOR OF 1.0** – Fluor-Western Cooling Tower Gears are rated in accordance with American Gear Manufacturer's Association standards calling for a materials factor of 1.0 for gears of a Rockwell "C" 60. *Less conservative* methods of rating permit the use of a materials factor of greater than 1.0 which, with all other factors being equal, will result in the size of the ring and pinion gear unit being reduced in the same proportion that the materials factor used is greater than 1.0.
2. **A STANDARD SERVICE FACTOR OF 1.5** – Fluor-Western Gears have a standard AGMA rated service factor of 1.5 which means that by *standardizing* on this service factor, Fluor customers are assured that the gear unit is designed for continual operation using electric motors or turbines.
3. **STRADDLE MOUNTED PINION** – Fluor-Western gear units feature a straddle mounted pinion. Far superior to the common cantilever type mounting, this Fluor-Western method of supporting the pinion between two rugged, long life bearings minimizes deflection, insures a smooth wear pattern across the gear teeth with quieter operation.
4. **SPIRAL BEVEL GEARS CASE-HARDENED** to 60 Rockwell "C" hardness calling for a materials factor of 1.0... gives longer service life than worm gears or flame-hardened bevel gears.
5. **WEBLESS-TYPE RING GEARS** which are much more rigid than web-mounted gears.
6. **A 100,000 HOUR MINIMUM B-10 BEARING LIFE** – The majority of bearings have a B-10 life in excess of 100,000 hours. In many instances, bearing life can be considered infinite.
7. **2 NEOPRENE SEALS** mounted back-to-back on the input shaft give *positive* protection against moisture leakage.



FLUOR PRODUCTS COMPANY OFFERS A GEAR PARTS REPLACEMENT CONTRACT!

To assure you of a fixed maintenance cost, Fluor Products Company offers a contract for gear parts replacement on new cooling tower installations.

FLUOR PRODUCTS COMPANY

A Division of The Fluor Corporation, Ltd.

MANUFACTURERS AND FABRICATORS OF COOLING TOWERS, PULSATION DAMPENERS, MUFFLERS, PREFABRICATED PIPING AND OTHER WOOD AND METAL PRODUCTS

General Offices—WHITTIER, CALIFORNIA

Wood Products Mill—SANTA ROSA, CALIFORNIA

Metal Fabrication Shops—PAOLA, KANSAS

SALES OFFICES AND REPRESENTATIVES IN: Birmingham, Boston, Buffalo, Chicago, Denver, Detroit, Houston, Kansas City, Los Angeles, Minneapolis, New York, Philadelphia, Pittsburgh, San Francisco, Tulsa.

ASSOCIATES: Fluor Corporation of Canada, Ltd., Toronto; Head-Wrightson Processes, Ltd., London, England.

TOUGH GRINDING MADE EASY...

Clean up castings and welds . . . deburr or do any portable snagging or grinding job faster and easier with this new Airetool grinder. It's light, rugged, easy-to-handle . . . packs plenty of power and speed — won't stall or heat-up under severe loads. Precision built Airetool air motor provides major operating economies and maintenance free service under constant work load.

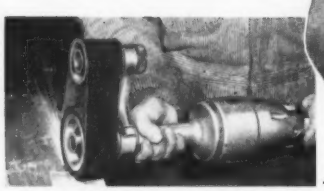
MODEL 700

Smooth, balanced design and light 12 lb. weight makes maneuvering easy. Control button operates speed up to 6000 RPM. Lever control valve also available.

NEW

air-motor

AIRETOOL GRINDERS



ABRASIVE BELT ATTACHMENT fits model 700 grinder. Ideal for fine finishing operations on dies, molds, seam welds or any contour surface.

RIGHT-ANGLE GRINDER Model 700A offers maximum convenience and working efficiency when grinding or sanding flat or curved surfaces.

Contact your AIRETOOL representative or write for Bulletin No. 61

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge

REPRESENTATIVES: In principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii

EUROPEAN PLANT: Vlaardingen, The Netherlands

CANADIAN PLANT: 37 Spalding Drive, Brantford, Ontario.

More EQUIPMENT NEWS

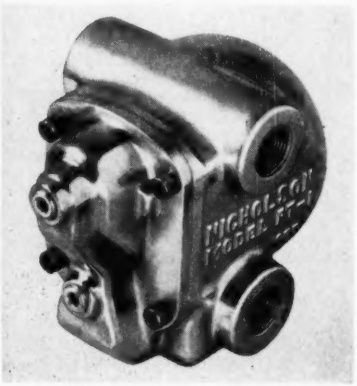
Begins on page 160

by trenching existing floor so ducts can be installed flush with surface of floor. Linoleum or other top surface materials are then laid directly over duct system.

Ducts are furnished in 10 ft lengths, with outlets spaced every 24 in. along the duct and each outlet closed with a brass cover plate. Equipment is available in single duct, two and three duct systems. Two and three duct systems are welded together. Linoleum pans are used to hold top floor covering and insure quick access to junction box hand-hole.

Complete range of standard fittings equipped with standard devices are available for system. Fittings equipped with a special nipple and insert adapter are quickly wired and installed. Request details.

National Electric Products Corp
Gateway Center, Pittsburgh, Pa.



Universal steam trap

229 • Float-thermostatic steam trap is suited for a wide range of applications requiring high discharge capacity at pressures up to 25 psig.

Unit features a discharge valve operation that is actuated by line pressure rather than by float buoyancy. Valves and seats need not be changed for any pressure within the trap's range. All internal mechanisms are attached to an easily removable cover plate.

Unit fits readily into existing piping layouts by virtue of its dual inlets and outlets which permit universal installation.

W H Nicholson & Co, 139
Oregon St, Wilkes-Barre, Pa.

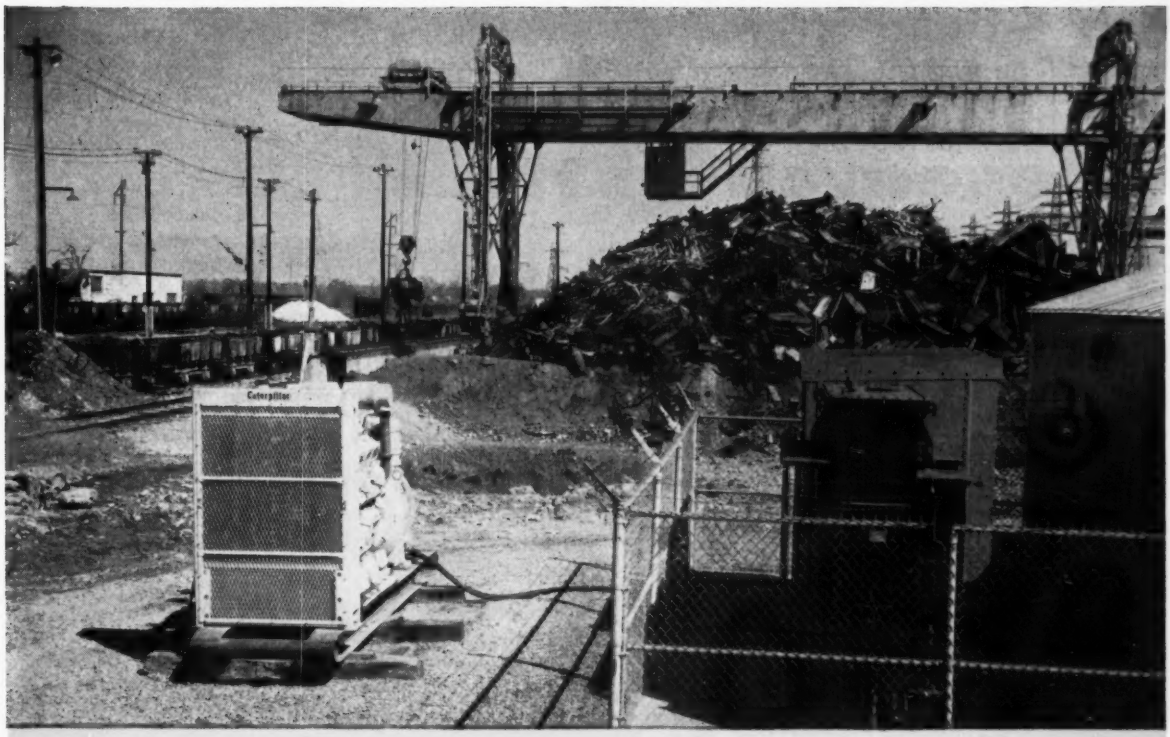
For more details on these items, use post cards p 169. Identify your request with item number.

Flareless tube fitting

240 • Flareless tube fitting is designed for a full range of pressure conditions.

Since a butt-joint is formed, tubing need not be sprung when making assemblies. Available in steel or stainless steel in a variety of sizes, fitting consists of a body, nut and alloy-steel sleeve. According to manufacturer, it is engineered to withstand high pressures, hydraulic surge, vibration

(*Continued on page* 180)



HERE'S STANDBY POWER doing more than standing by

A large Texas steel mill bought this Caterpillar D375 Electric Set as standby power for 8 open hearths. But it's not sitting around waiting to go into action. Here you see it furnishing electricity for scrap yard cranes while the main feed rectifier is in repair. There are 5 gantry cranes in this yard; the hearths they feed take 225 tons per charge, charging every 8 or 9 hours.

This steel mill has 20 other CAT* Diesel Engines and Electric Sets on the job. They power locomotives, hoists and shovels, and provide emergency standby service as well.

Standardizing on Cat Diesels saves maintenance costs. It means a smaller parts inventory, since Cat-built parts are interchangeable among different models. It means fast dealer service and less down time.

The D375 in this picture is a Roots-blown electric set putting out 200 KW at 1200 RPM. Other models range from 30 to 350 KW, 60-cycle. They're available 50-cycle, too—as well as DC, which the steel mill needs for its hearth cranes.

Contact your Caterpillar Dealer for complete details on his full line of dependable, tinker-free electric sets for standby or operating power. He has just the right size for your job. He offers experienced service, too—and parts you can trust. Call him soon.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

A QUARTER CENTURY OF DIESEL LEADERSHIP

First
Research-Cottrell
"Double-Deck"
Fly Ash Precipitator

Space was a big problem in this installation at the Burlington Generating Station of Public Service Electric and Gas Company of New Jersey. Two integral combination mechanical-electrical precipitators, large enough to handle 600,000 cfm of gas from Boiler No. 7, had to be squeezed into the smallest possible ground area.

If a conventional side-by-side arrangement had been used, these two units would have required about 1,700 square feet. By "stacking" the two combination precipitators, one on top of the other, Research was able to cut this space requirement by 50% — a saving of 850 square feet.

Although this arrangement had never been attempted with Research fly ash precipitators, Research knew from their experience with more than 500 central station Cottrells that it could be done. Guaranteed for 97% collection efficiency, these Burlington Generating Station units were placed in operation in October, 1955.

Perhaps you, too, have a knotty problem that demands a more creative approach — backed up by experience with over 500 fly ash precipitators. Whether you require a straight precipitator or a combination unit, at Research-Cottrell you can be sure of the most economical solution to your problem.

Other Research-Cottrell Precipitators at Public Service Electric and Gas Company of New Jersey

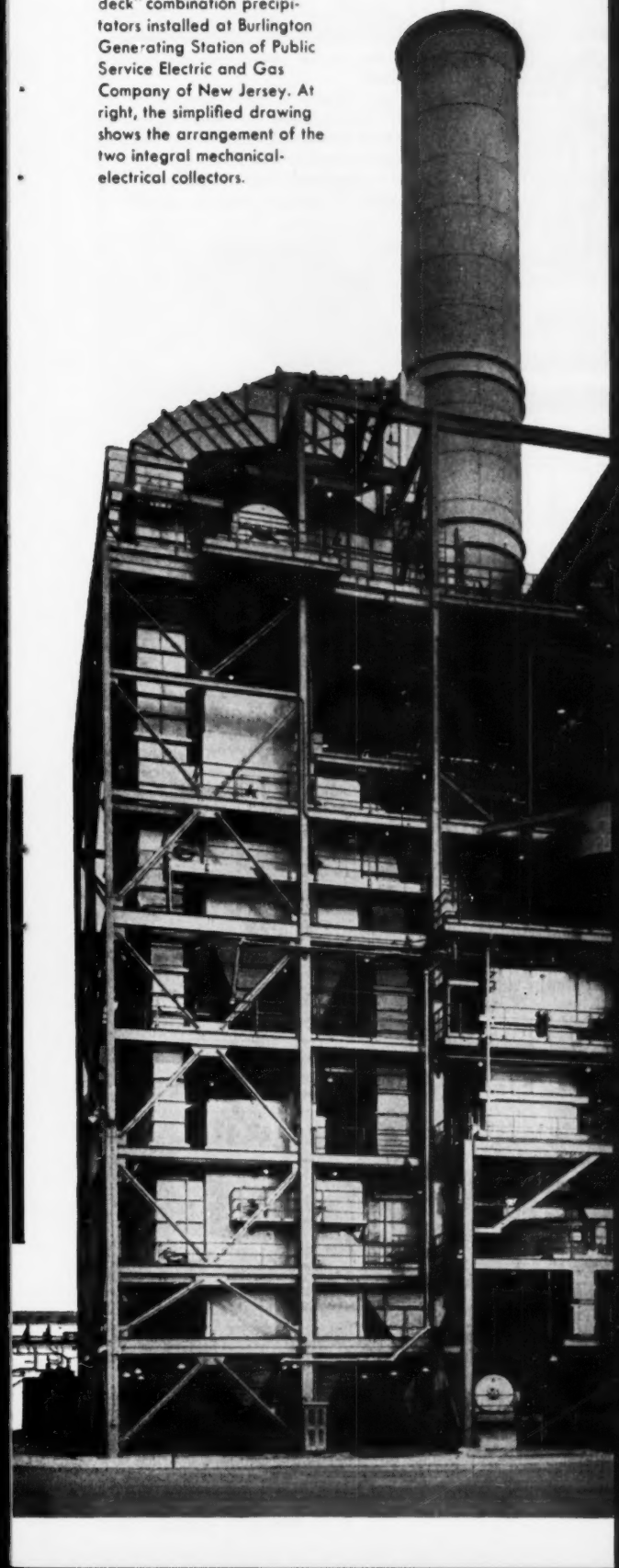
Installation Date	Generating Station	Boiler Number	Number of Pptrs.	C. F. M.
1937	Burlington	11	1	270,000
1938	Essex (Newark)	25 and 26	4	520,000
1940	Burlington	12 and 13	2	448,000
1941	Marion (Jersey City)	51 and 52	2	448,000
1942	Burlington	14 and 15	2	448,000
1946	Kearny	1 (Mercury Blr.)	1	160,000
1947	Essex (Newark)	1	3	380,000
1955	Burlington	7	2*	600,000
		Total	17	3,274,000

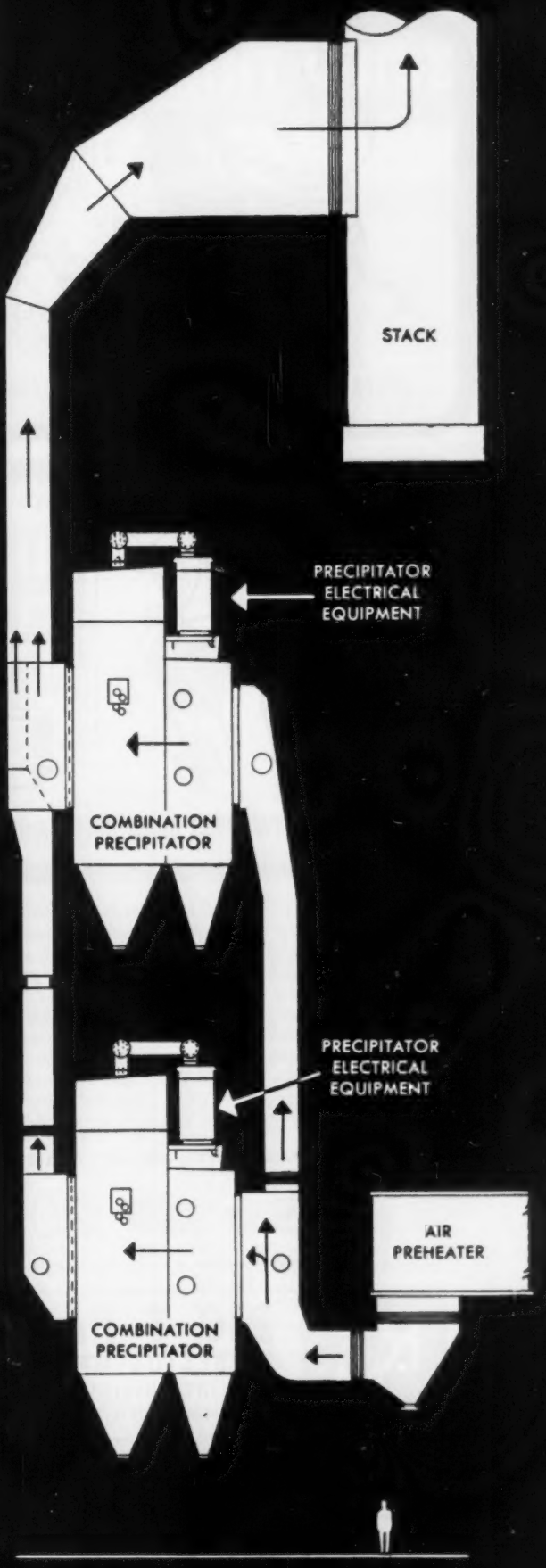
*"Double-Deck" Arrangement

Research-Cottrell, Inc.

Main Office and Plant: Bound Brook, New Jersey • 405 Lexington Ave., New York 17, N. Y.
Grant Building, Pittsburgh 19, Penna., 228 No. La Salle St., Chicago 1, Ill. • 111 Sutter Bldg., San Francisco 4, Cal.

Research-Cottrell's "double-deck" combination precipitators installed at Burlington Generating Station of Public Service Electric and Gas Company of New Jersey. At right, the simplified drawing shows the arrangement of the two integral mechanical-electrical collectors.





ENTER PETE PACKING ON A SCENE OF COMPLETE CHAOS

R/M BIG 7 PACKINGS BRING ORDER AND HAPPINESS

It's all in the book. The story of how R/M's Big 7 Packings can make a *show* place out of the *slow* place that used to be your stockroom. With the line reduced to 7 basic packings, of which you will probably need only 3 or 4, your whole packing problem will be greatly simplified and your maintenance operations speeded up. What's more, with these basic packings you get peak performance and reduce inventories, simplify ordering, cut investment. In addition, the chances of error through selecting the wrong packing for the job are practically nil. That's a lot of advantages for you.

Call in your R/M distributor and discuss your packing problems with him. He knows his business and will quickly show you how R/M Big 7 Packings can make your job easier.

R/M's BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS

R/M packings for maintenance purposes are sold only through authorized R/M distributors

R/M **BIG 7 PACKINGS**
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

FACTORIES: Passaic, N.J.; Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks Clutch Facings • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

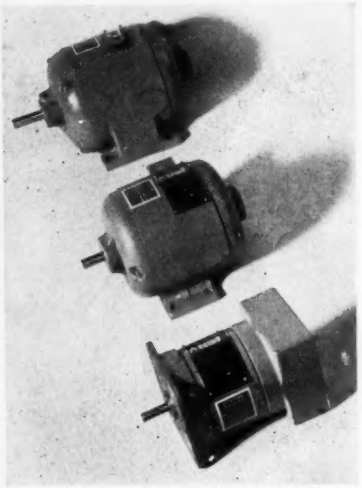
More EQUIPMENT NEWS

Begins on page 160

and other severe operating conditions. Shoulder on the sleeve prevents incorrect assembly.

Unit features a triple seal. Will not move longitudinally in assembly, scrape or shave tubing, and there is no torquing of tube when making joint.

Imperial Brass Mfg Co,
1200 W Harrison St, Chicago, Ill.



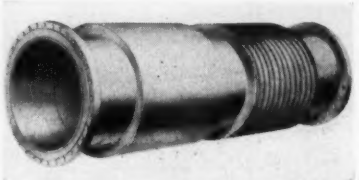
Torque-brake units

241 • These three compact torque-brake units give a wide range of speed-torque characteristics. Designed to provide continuous tension, these motors are said to be especially applicable to wire-winding.

Pictured at top is the *5830* frame, continuous duty, open torque-brake unit. Diameter 6⅝ in., length 9½ in. Center unit is *5220* frame, continuous duty, open torque brake unit. Diameter 5⅝ in., length 7⅝ in. Bottom, *3520* frame, continuous duty, totally enclosed unit. Diameter 4 in., length 5 in. All three are 220 v, 3 ph, 60 cycle.

B A Wesche Electric Co,
1622 Vine St, Cincinnati 10, Ohio

For more details on these items, use post cards p 169. Identify your request with item number.



Packless expansion joints

242 • Line of packless corrugated expansion joints are redesigned for use in power, heating, industrial and process piping applications.

Joints are available in several types which are classified in series according to pressure-temperature conditions to be en-

(*Continued on page* 184)

TURBINE AND DIESEL LUBRICANT GUIDE

CITIES SERVICE TURBINE OILS

Manufactured from the highest quality, solvent refined stocks, these oils have high viscosity index, excellent heat resistance. They are chemically fortified to prevent oxidation, rust, and foaming, permit smoother operation.

PACEMAKER 300-T

For use in the lubrication of steam turbines with single reduction gear units. Also for the lubrication of high-speed, ring-oiled, auxiliary turbines, where operating temperatures are not above 200°F.

PACEMAKER 500-T

Suitable for the lubrication of ring-oiled bearings of auxiliary turbines where operating conditions require an oil of heavier body than Pacemaker 300-T. Also recommended for use in separately lubricated turbine gear reduction units.

PACEMAKER 150-T

Recommended for pressure-circulation systems of direct-connected steam turbines, and for the bearings of turbo-generators where pressure-circulation of the oil is employed.

PACEMAKER 400-T

Recommended for the lubrication of propulsion turbine units on naval and commercial vessels, in pressure-circulation systems.

PACEMAKER 750-T

Recommended for the lubrication of high-speed, ring-oiled, auxiliary turbines, where operating temperatures are in excess of 200°F., and use of a heavier bodied oil is required.

CITIES SERVICE DIESEL OILS

Made in the world's most modern lubricating oil refinery at Lake Charles, Louisiana, Cities Service Diesel Oils are blended from highest quality, high V.I. mineral oils and fortified with specially developed additives. There's a Cities Service Diesel Oil tailored for top performance in every type of diesel operation.

D-C 300 SERIES

These oils are designed to fully conform to Military Specification MIL-L-2104A. Made from the finest base oils, they are strongly fortified against oxidation and corrosion. They have the necessary detergent-dispersant properties to insure superior lubrication performance in high speed Diesel engines operating under heavy duty service.

Recommended for service DG under A.P.I. classification system.

D-C 100 SERIES

These oils are designed to conform to U. S. Army Specification 2-104B (Supplemental List 1). They are also known as Superior Lubricants Series 1 and are intended for more severe service than the D-C 300 Series Oils. Particularly recommended for the lubrication of medium and high-speed Diesel engines using lower quality fuels.

Recommended for service DM under A.P.I. classification system.

D-C 500 SERIES

These oils meet the requirements of The Caterpillar Tractor Company for a "Superior Lubricant (Series 3)". They have the highest level of detergent-dispersant action with maximum oxidation and corrosion protection to assure reliable operation of Diesel engines under most severe service conditions or where low quality fuels of very high sulphur content are used.

Recommended for service DS under A.P.I. classification system.

PACEMAKER SERIES

The new Pacemaker line of Diesel engine oils is made from the same high quality base oils as are the Pacemaker T Series, and contains similar additives, but in lesser amounts. These oils are adaptable for use in many low and medium speed stationary engines operating under conditions which would not require the use of heavier fortified oils, such as the Pacemaker T Oils.

PACEMAKER T SERIES

These are medium duty, high grade, high V.I. oils fortified against oxidation, rust and foam. Admirably suited for slow and medium speed engines employing the dry sump system of lubrication and operating under conditions where the service is not severe enough to benefit from a full heavy duty oil.

NEPTUNE 9000 SERIES

Designed specifically for lubrication of marine-type Diesel engines, both military and commercial.

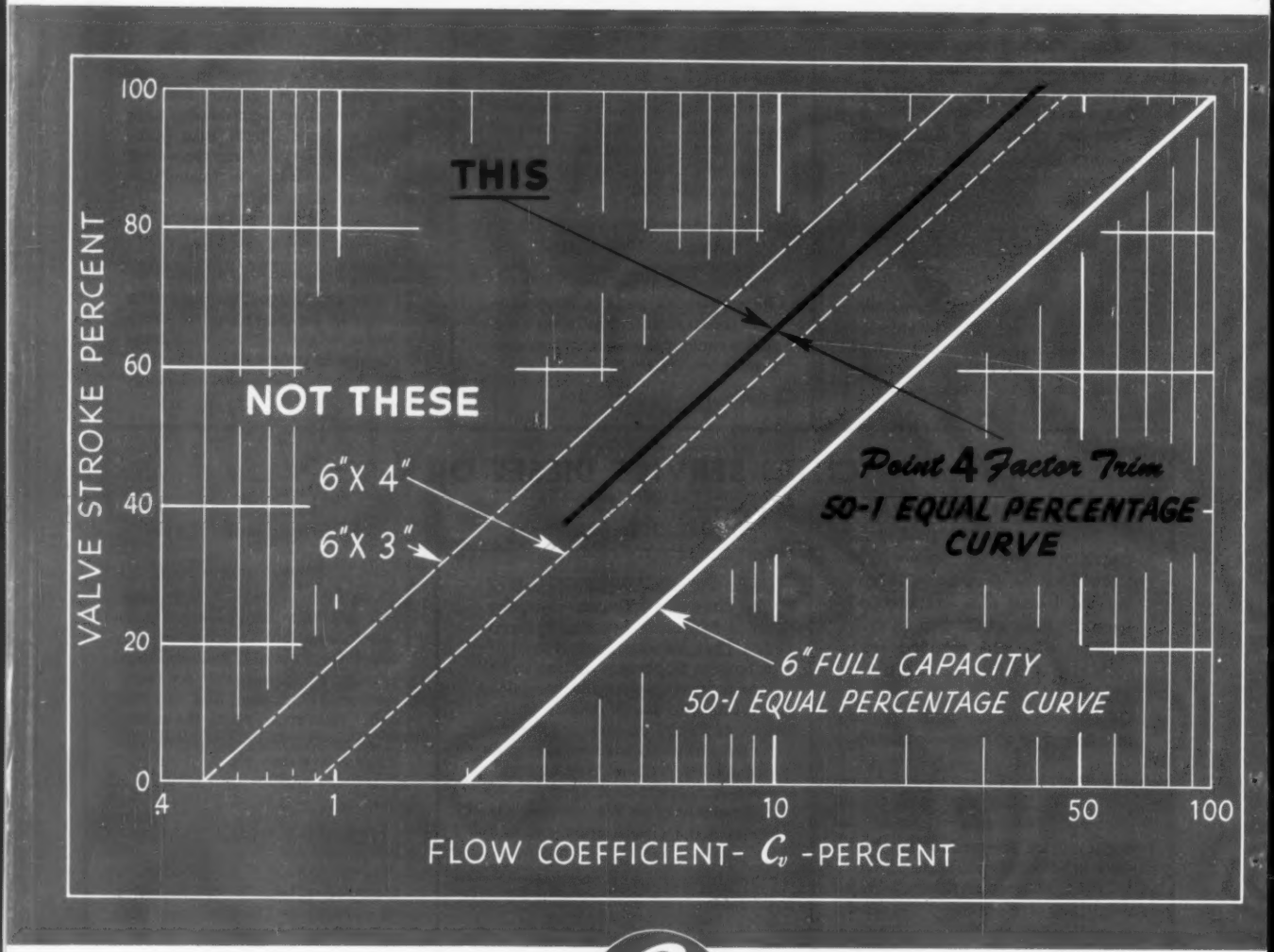
Neptune 9000 Series Oils are made from high quality, high V.I. solvent refined stocks and are strongly fortified against oxidation and corrosion. They are specially inhibited against silver alloy bearing corrosion and have the necessary detergent-dispersant properties to give maximum performance under severe operating conditions.

These oils conform to the requirements of Military Specification MIL-L-900 C (SHIPS) for marine Diesel engine lubrication.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

One Size...



A HIGH Cq Quality Coefficient PRODUCT

Point 4 Factor Trim

is the answer to those few types of applications where reduced capacity trim is required. It is available in V-port and solid turned designs for double or single seated valves and in a wide variety of materials. Send for Data Sheet No. 10-5.

Not Two

Masoneilan *Point 4 Factor Trim* offers the ONLY REALISTIC approach to selection of reduced capacity trim

It is a DEMONSTRABLE Fact that for a given size top-and-bottom guided valve only *one* size reduced capacity trim is:

Desirable from an engineering standpoint because . . .

(a) properly designed wide-range valves with full capacity trim will handle a vast majority of control problems.

(b) if any reduction is required, it must be substantial to be of any advantage.

(c) any sound design must be based on a reduction in seat ring diameter.

(d) rule-of-thumb trim reductions based on nominal *pipe* sizes are unnecessary and merely complicate the sizing problem.

Practical from manufacturing and operating standpoint because . . .

(a) mechanical strength is retained with standard guide and stem diameters and standard stroke, in combination with maximum reduction in seat diameter.

(b) reduction in number of parts simplifies stock problem.

(c) forged and cast forms insure complete uniformity of parts.

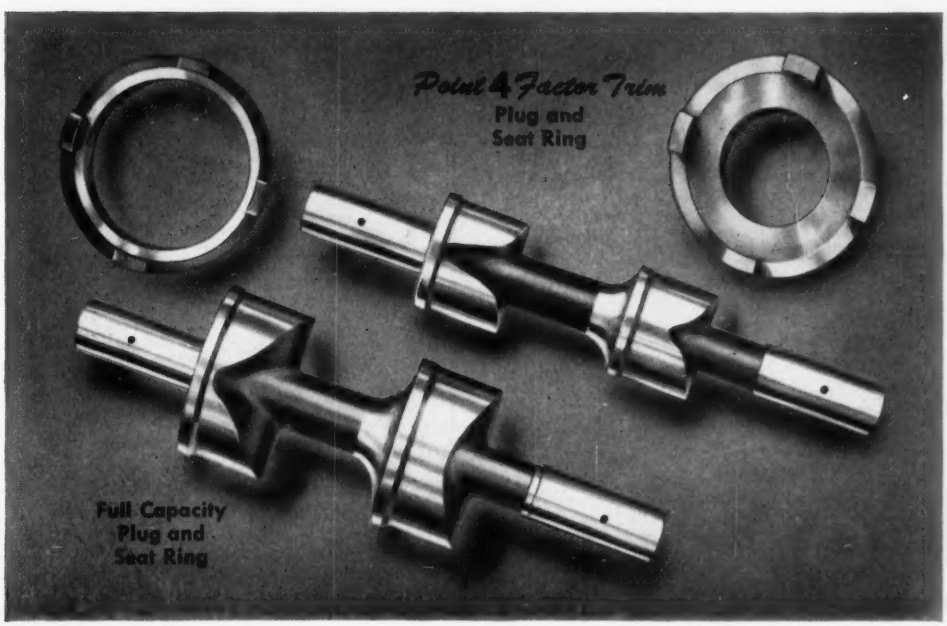
MASONEILAN

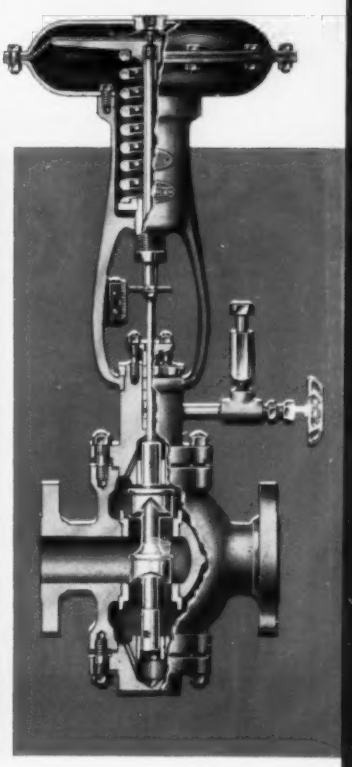
MASON-NEILAN

Division of Worthington Corporation

33 NAHATAN STREET, NORWOOD, MASSACHUSETTS

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis Tulsa • Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati Livonia • San Francisco • Boise • Louisville • Salt Lake City • El Paso • Albuquerque Odessa • Charlotte • Los Angeles • Corpus Christi • Denver • Appleton • Birmingham New Orleans • Dallas • Seattle • Mason-Neilan Regulator Co., Ltd., Montreal and Toronto



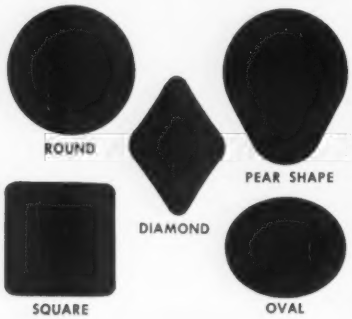


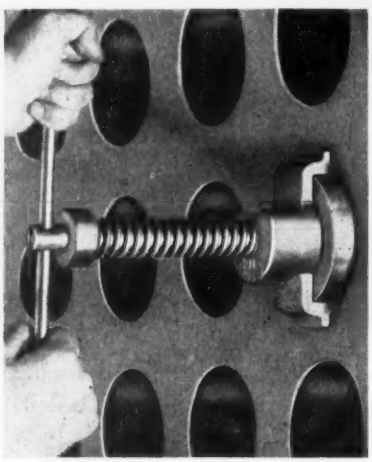
ROTO *Hand Hole* Seat Scraper

Eliminates Dirty, Tedious Work

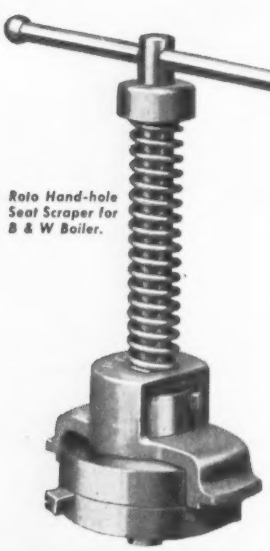
Here is a simple, hand-operated tool for cleaning inside caps on boilers that will pay for itself many times over. This tool is equipped with retractable knives mounted on a revolving spindle having a bearing within a substantial yoke. An adjustable spring automatically maintains tension on the knives, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right, and the job is done. A half turn to the left releases the tool. Try a Roto Seat Scraper and you'll wonder how you ever got along without one.

These are some of the hand hole shapes cleaned with a Roto Seat Scraper. Various sizes available.





Illustrating ease of operation of Roto Hand-hole Seat Scraper.



Roto Hand-hole Seat Scraper for B & W Boiler.

What Users Say—

It did a fine job. Completed the work in 80% less time.
(Engineer, Chemical Plant)

Roto Seat Scraper has paid for itself many times over on our Keeler Boiler.
(Supt., Public Utility)

One man cleaned inside cap seats on boiler header in 4 hours. Formerly took 2 men 3 days.
(Pennsylvania Manufacturer)

We also make a Reseating Machine for cleaning outside caps to assure a smooth, true fit. Send for details.

SEND FOR BULLETIN

ELLIOTT COMPANY - ROTO DIVISION
Tube Cleaner Specialists Since 1910
153 Sussex Avenue, Newark, N. J.

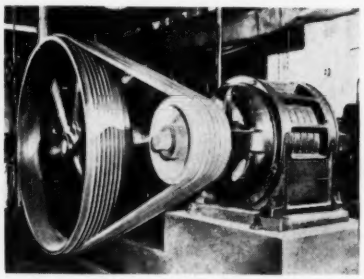
More EQUIPMENT NEWS

Begins on page 160

countered in much the same way that pipe flanges are rated by ASA. Thus, joints in *Series 50* are for lower line pressures while joints in *Series 150* and higher are for higher pressures.

According to manufacturer, most notable design change is found in shape of corrugations which form flexing member. New shape gives each corrugation a more effective height which is said to result in greater flexibility and therefore more uniform movement per corrugation.

Badger Manufacturing Co,
230 Bent St, Cambridge, Mass.



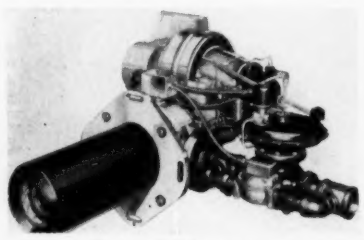
High-capacity V-belt

243 • Unit is designed for applications where increased power transmission is desired with a minimum of maintenance. Belt is available in standard sizes, features oil-resistant cover to prolong belt life.

According to manufacturer, lower drive costs can be achieved since fewer belts and narrower sheaves are required to handle a load. Bearing life is increased because of lighter weight and lower stresses.

Thermoid Company,
200 Whitehead Rd, Trenton, N. J.

For more details on these items, use post cards p 169. Identify your request with item number.



Pressure burners

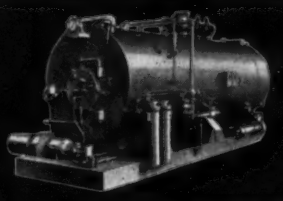
244 • Units are designed to fire scotch-marine-type boilers and similar compact steam generators. Units are able to work against combustion chamber backpressures of 3 in. of water or more and so do not require a high stack or any induced-draft equipment.

Sizes cover range of boilers from 10 to 150 hp ratings. They come in three different types—for gas firing, oil firing, or combination gas or oil firing.

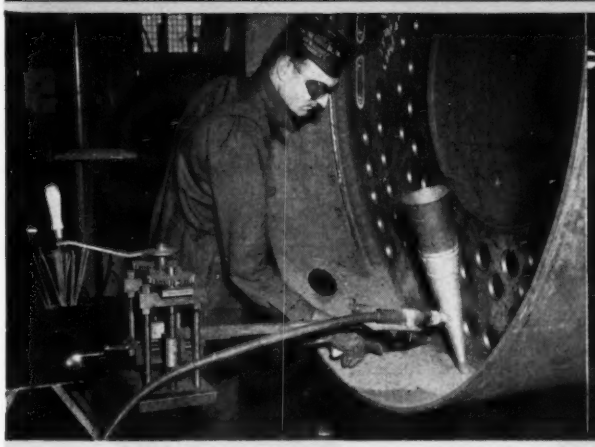
Synchronous Flame, Inc,
Walworth, Wis.

(*Continued on page* 187)

AMESTEAM GENERATOR

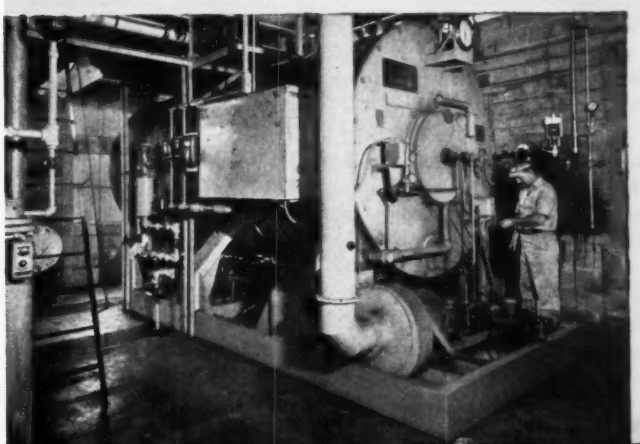


Gives you EXTRA YEARS of SERVICE



CONSTRUCTION THAT EXCEEDS CODE REQUIREMENTS goes into every step in the making of an AMESTEAM GENERATOR. Here, the tube sheet is automatically welded to the shell. Tubes are rolled and *re-rolled* after stress-relieving to insure an absolutely tight sheet and long life. The insulation jacket is 16-gauge, not the usual 24-gauge.

"FINAL EXAMINATION" which every AMESTEAM GENERATOR must pass is the fire test under conditions duplicating those of the customer's operation. All component parts are specifically designed and fabricated for AMESTEAM GENERATORS — assembled, inspected and tested in the Ames factory, not merely purchased and shipped from one point.



— PLUS EVERY OTHER FEATURE FOR RELIABLE, LOW-COST STEAM

Most important to the user is the Ames 3-pass concentric tube design — inherently efficient and simple to maintain — free of the ill effects of thermal expansion and contraction encountered in most other boilers. The maximum flexibility of the tube sheets in AMESTEAM GENERATORS occurs at the point of maximum expansion, while minimum flexibility occurs at the point of minimum expansion — a vital protection against untimely metal fatigue. Just one of many reasons why you're safe and sure when you specify "AMESTEAM GENERATOR". Write for catalog and name of your nearby Ames sales and service representative.

STRENGTH FOR THE YEARS AHEAD!

Your AMESTEAM GENERATOR is shipped in firing condition with an inbuilt bonus of durability and performance beyond standard boiler requirements. Note rugged construction of every component from skids to steam outlet — Ames "extras" that provide support and protection for the boiler during shipment and years of operation.

AMES IRON WORKS INC.

BOX H-27 OSWEGO, N. Y.

NO REBORING—

NO KEYSEATING—

NO MACHINING—

NO WAITING!

TAPER-LOCK SPROCKETS
SINGLE AND DOUBLE STRAND!

NOW Taper-Lock *Double* Strand Sprockets are available—from stock—ready for the shaft without re-machining!

They offer all the advantages of Taper-Lock mounting. Easy on! Easy off! Precision machined at the factory, they come to you with accurate, concentric bores—insuring full contact between hub and shaft. Taper-Lock grips with the firmness of a shrunk-on fit!

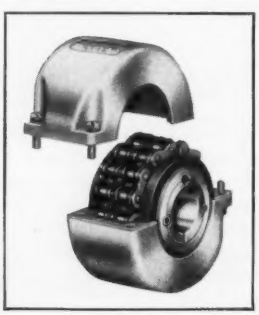
There is no flange, no collar, no protruding part. Flush design means *safety*... If the sprocket becomes worn, you replace only the tooth part. The bushing is used again and again. And Taper-Lock bushings are interchangeable in Dodge Taper-Lock Sheaves, Couplings and Conveyor Pulleys!

Taper-Lock Sprockets and Dodge Roller Chain (made to ASA standards) are stocked by Dodge distributors. Single Strand sizes range from No. 40 to No. 160, up to 112 teeth; Double Strand from No. 40-2 to 80-2, up to 102 teeth. Write for Bulletin A-644 containing selection, installation and maintenance data.

DODGE MANUFACTURING CORPORATION
3200 Union Street, Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new methods. Look for his name under "Power Transmission Machinery" in your classified phone book, or write us.

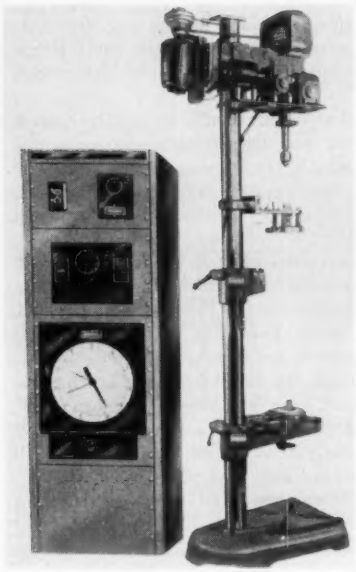


TAPER-LOCK CHAIN COUPLINGS

Accommodates common minor shaft misalignments. Provides strong, compact coupling. Available with covers, for appearance, safety, dirt protection and lubrication—which increases coupling life.

More EQUIPMENT NEWS

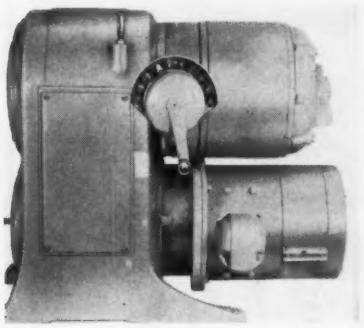
Begins on page 160



Single crystal puller

226 • Designed for maximum single crystal silicon or germanium production, unit is also said to have the flexibility and design refinements required for laboratory work. According to manufacturer, total quantities of single crystals that can be produced will vary with techniques and requirements of the operator. Production rates of 300 grams of single crystal silicon and excesses of 1000 grams of single crystal germanium per 8-hr day have been reported, according to manufacturer. A separate cabinet contains controls for the unit.

Precision Tool & Engineering Co
92-26 180th St, Jamaica 32, N.Y.

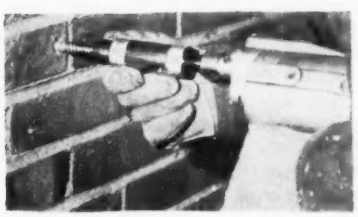


Power-system unit

230 • *Varidyne* power unit is designed with drive motor and alternator on same side. Unit provides variable frequency power to *Varidyne* motors in the system, thus linking them together. This system has converted standard 60 cycle, 3-phase, ac squirrel-cage motors into variable-speed motors. Alternator, driven at variable speeds, generates a frequency proportionate to its speed and transmits this variable frequency to each of the *Varidyne* motors in the system. By changing speeds at the power unit by means of a handwheel, each motor in the system varies equally and simultaneously.

According to manufacturer, system is easy to understand, easy to service and install, and offers a wide selection of motor types in regard to enclosure and speed range. Enclosures available include drip-proof, totally enclosed and explosion proof designs. Wide variety of internally-geared motors such as single, double and triple reduction as well as right-angle worm gearing may be used. Details on request.

U. S. Electrical Motors Inc, Box
2058 Terminal Annex, Los Angeles



Electric-drill attachment

224 • Pneumatic impact action for high-speed drilling in concrete, brick and masonry can be obtained with any ¼-in. electric drill by means of a rotary impact drill attachment. Unit is 6 in. long by 1½ in. in diameter.

Said to be able to drill ½-in. holes 3 in. deep in concrete within 30 seconds, attachment employs a 25-lb. pre-loaded spring and two rotating cams to provide two blows per revolution. Unit may be chucked to any ¼-in. electric drill, develops approximately 90,000 fpm impact force, according to manufacturer. Details on request.

Power Tools Corp, 1425
Lakeside Ave, Cleveland, Ohio

For more details on these items, use post cards p 169. Identify your request with item number.

Dosimeter pens

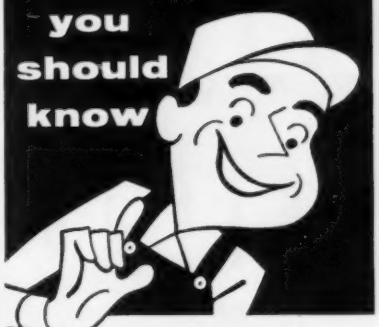
233 • Family of lightweight dosimeter pens, ranging from 200 milliroentgens to 100 roentgens, are designed for safety and quick, accurate measurement of radiation accumulation, according to manufacturer. Manufacturer has also developed a compact transistorized dosimeter charger that charges any number of standard dosimeter pens in a few seconds.

Pens are direct-reading, self-contained electrometers designed for the protection of civilian defense, medical, laboratory and other personnel who work with radioactive material or x-ray equipment. Each pen weighs 1/3 of an oz and is packaged in a metal case with a pocket clip.

Charger has no neon regulators or glass of any sort (except for flashlight bulb). It operates from a single standard flashlight cell, weighs less than one pound.

Universal Atomics Corp
143 E 49th St, New York 17, N. Y.

DODGE PRODUCTS you should know



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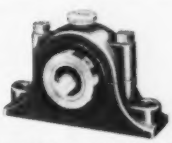
THE DRY FLUID DRIVE
100% efficiency at full load!

TORQUE-ARM
SPEED REDUCERS
Cost less—deliver more!



DODGE-TIMKEN
America's Quality Pillow Blocks!

DODGE BULLETINS YOU SHOULD HAVE—

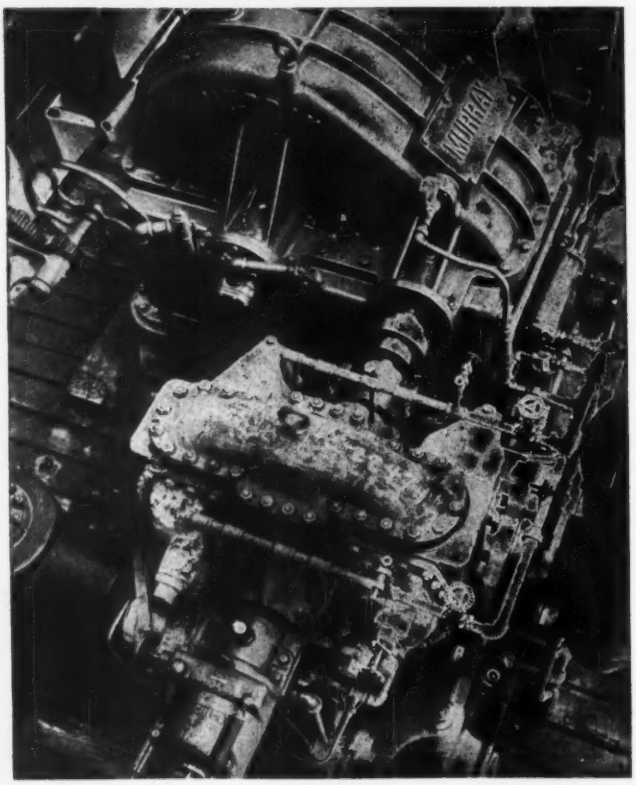
- Flexidyne Dry Fluid Drives and Couplings. Bulletin A-640-A.
- Torque-Arm Speed Reducers. 15 sizes—1 to 90 hp. Bulletin A-637.
- Roller Bearings. Load ratings, dimensions, etc. Bulletin A-638.

Write for your copies.
DODGE MANUFACTURING CORPORATION
3200 Union Street • Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

Murray Turbines

OUTDOOR INSTALLATION?



THE RIGHT ANSWER—MURRAY

The turbo-gear unit shown above has been installed outdoors with virtually no weather protection for many years. The turbine exhausts to a process line carrying 170 psig pressure. Yes—for rugged applications—the right answer—MURRAY.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

COOLING TOWERS

Continued from page 97

signed to break it up and distribute it evenly. If these splash surfaces are improperly located, water distribution is poor.

Tower fill should be evenly spaced, level and free from algae accumulation. Otherwise water tends to run off in large streams instead of distributing itself evenly. Promptly replace any defective tower fill.

Air entering from the sides of a cooling-tower cell tends to blow the water droplets toward the inside of the cell. A small amount of this is good, as it prevents water from splashing on the outside of the tower basin. But too much gives less effective air-water mixing. Two ways to improve horizontal water placement are to adjust tower fill position and use special baffles.

Tower capacity. Towers designed for a certain water flow usually have a small margin of excess flow capacity. But if increased flow floods sections or causes severe trough spillage, or if water flow becomes so heavy that air flow is reduced, tower performance falls off rapidly. Reduced water flow usually improves tower performances to a point after which performance deteriorates.

Manufacturers can often supply curves that predict the effect of higher or lower than normal water flow on tower approach to wet-bulb temperature. These are in addition to the usual curves that show performance for various ranges and wet-bulb temperatures with design-water flow.

Cool weather operation. As weather becomes cooler and wet-bulb temperatures fall lower, it often pays to reduce water flow and cut a few tower cells out of service. But you won't save money if water flow cannot be cut except by throttling circulating-water valves. Where fans have several speeds, a lower speed may move enough air through the tower and save power to boot. Determine the characteristics of each tower and its associated equipment by test or trial. Then you can determine the most economical operating procedure for various loads and wet-bulb temperatures.

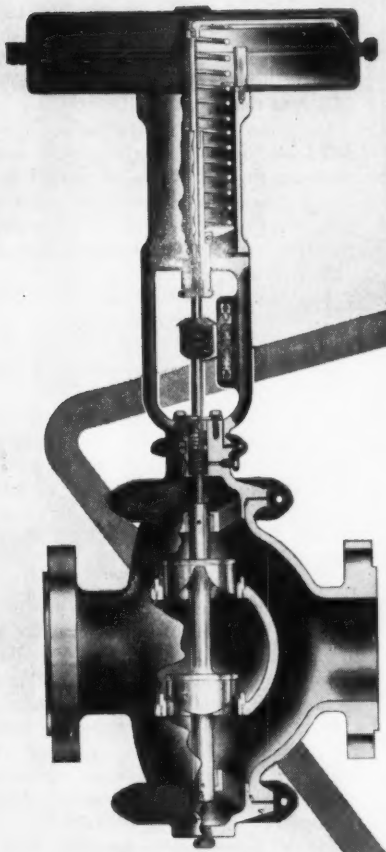
As air temperatures fall, less moisture is absorbed by a pound of dry air in producing a one-degree rise in wet-bulb temperature. This means that a power's approach is inherently poorer as the temperature drops. For most installations, leaving-water temperature is not much below 60 F even if air temperature is at or below freezing. Run tests to determine the most economical method of tower operation for lower temperatures.

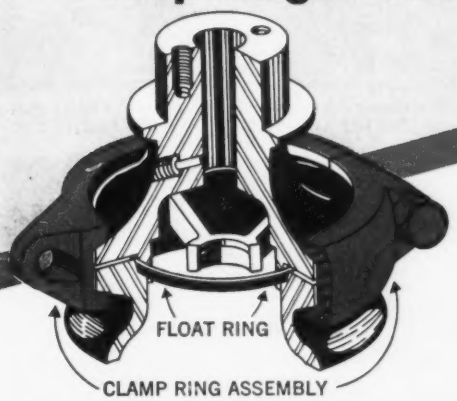
(*Continued on page* 190)

New Clamp Ring···Float Ring Seal*

On BS&B's *Super* 70 series

Diaphragm Control Valves





. . . Makes Other Valve Closures Obsolete!

* Patented

The BS&B Super "70" Series Diaphragm Control Valves offer a thoroughly proven concept of pressure sealing, known as the clamp ring — float ring seal, for top and bottom closures.

Tightening of the heavy forged steel clamp ring seals the nickel plated, soft steel float ring into a precision machined, wedge-shaped groove formed by the valve body and the closure plate. Float rings are available in other materials compatible with alloy or stainless steel valve bodies.

Under pressure, the float ring is wedged tighter into its annular groove — thus increasing the sealing force. The higher the internal pressure, the tighter the seal!

This actuation under pressure also creates automatic compensation for thermal expansion under fluctuating temperatures. The seal is maintained under vacuum because initial tightening of clamp ring provides sufficient sealing force to hold a vacuum differential of up to 15 psi. Valves may be disassembled as often as required without damage to the clamp ring — float ring seal.

While a new BS&B exclusive feature in the diaphragm valve field, the float ring seal concept has also been most successfully used over the past several years by other leading manufacturers of high pressure equipment.

Why Clamp Rings Are Used On Super "70" Series Valves

The equivalent bolting area of the clamp rings used on Super "70" Series Valves is greater than that of a similarly rated ASA flange — yet is lighter in weight and more trim in appearance. Clamp rings make the valve easier to disassemble for servicing and cleaning because only two bolts must be removed, and permit the valve yoke to be oriented to any convenient position.

For more information on the all-new BS&B Super "70" Series Diaphragm Control Valves, ask your BS&B Sales Engineer — or write for Catalog 70-11.

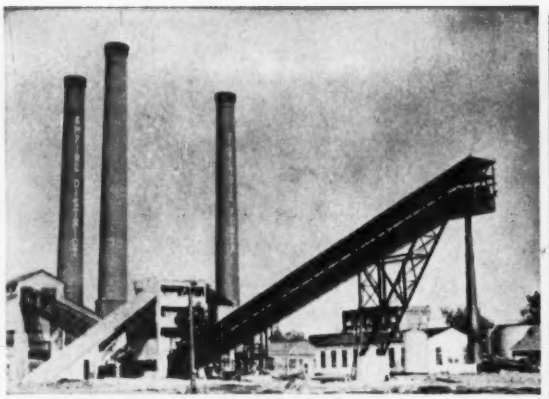
EFFICIENCY OVER 60 YEARS BS&B RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-Q2

7500 East 12th Street Kansas City 26, Missouri

EARN EXTRA PROFITS IN SAVINGS



McNally Pittsburg developed this 250 ton per hour system for the EMPIRE DISTRICT POWER & LIGHT CO.

McNally Pittsburg assisted in developing this 300 ton per hour system for the KANSAS POWER & LIGHT CO.

—With Cost-Cutting

COAL-HANDLING SYSTEMS

Engineered for Your Plant

Are you paying "extra fare" luxury rates for that last ride your coal must take from the truck, car, or barge, to your bunkers?

Why pay more? Why risk breakdowns, when you can *save* extra "profits" and be sure of year-round efficiency.

McNALLY PITTSBURG Systems automatically handle more coal per dollar—minimum maintenance costs.

The men who know coal from the ground up will be glad to study your coal-handling problems with you. Mail coupon.

McNALLY PITTSBURG

"The Men Who Know Coal From The Ground-Up"

McNally Pittsburg Mfg. Corp., Dept. PO, Pittsburg, Kansas
Gentlemen: Send more information on your Coal-Handling Systems.

Name_____ **Title**_____

Company_____

City and State_____

COOLING TOWERS

Continued from page 188

Freezing temperature operation. When air temperature is much below freezing, you need special precautions to prevent tower damage. Ice tends to accumulate at points of cold air entry, if only a spray of water falls there, rather than the large streams that fall in other portions of tower. Ice may accumulate until it practically shuts off air flow through the cell. Ice weight may also tear down tower fill.

On forced-draft towers the ice may build out until it interferes with and damages the fan blades. If air restriction becomes severe, tower performance may become very poor. So you may have high water temperatures during extremely cold weather.

Inspect tower hourly or even more often in cold weather. See that ice inside and outside the tower is not excessive. Be particularly careful on the windward side.

With two-speed fans, lower speed operation usually reduces the tendency for ice formation. It also saves power. Shutting fans down completely is still more effective. But some of the fans usually are kept running to keep water temperatures down. Rotate the ones in service regularly.

Some towers have reversible fans so you can blow warm air outward for a few minutes to melt the ice deposits. This is often quite effective, but you need special motor-reversing switches. Also, some gears on induced-draft fans are not built for reverse operation, at least for any period of time. Consult the tower or gear manufacturer before trying it.

If inlet louvers freeze, removing some or all of them may eliminate the obstruction without causing too much splash.

Ice deposits on tower stairs, walkways and adjacent structures and wires are largely beyond the operator's control. But he can see that drift eliminators are in place and working properly. To insure against accidents in freezing weather, sand walkways, provide adequate handrails and employ careful operators.

Tower basins are normally built of concrete and do not require much attention. Clean them occasionally and repair any cracks or defects. If a tower is to be shut down for several days in cold weather, drain the basin. This prevents heavy freezing and cracking.

Collecting passages where water from the basin enters the pipe carrying it to the circulating pumps are usually made deeper to provide adequate pump submergence. These deeper parts need drains, too. You also need a blowdown

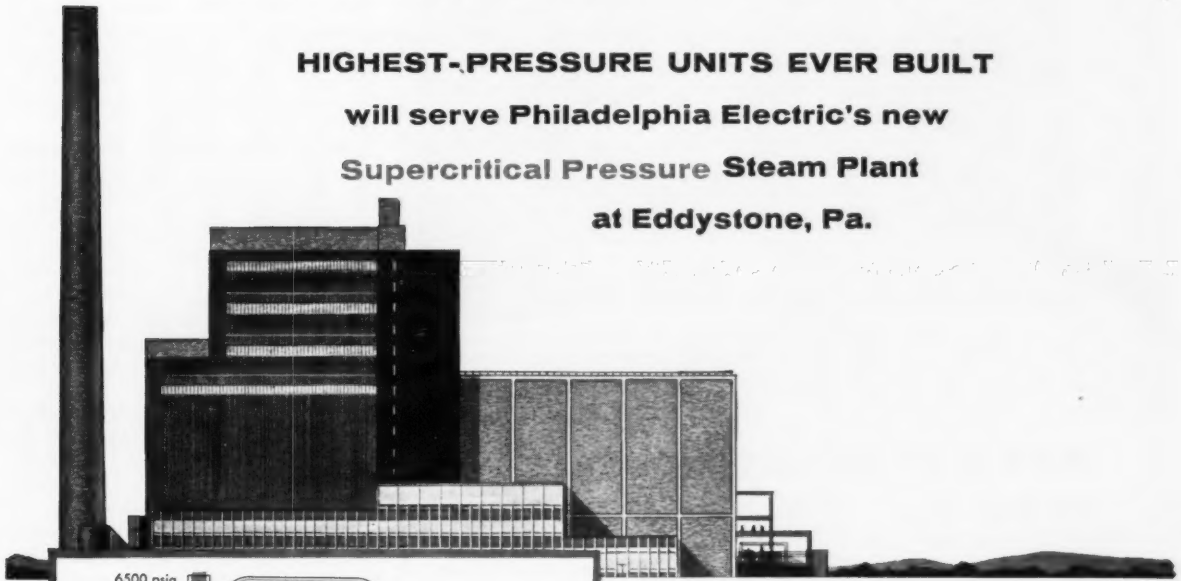
6500 psig
BOILER-FEED PUMPS

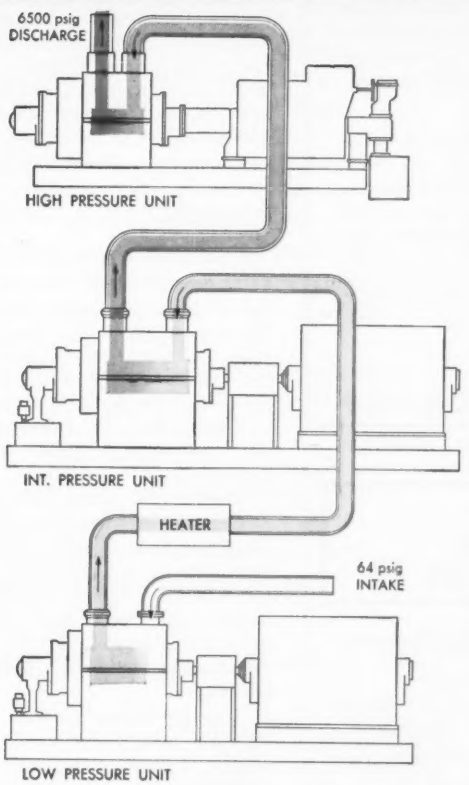
HIGHEST-PRESSURE UNITS EVER BUILT

will serve Philadelphia Electric's new

Supercritical Pressure Steam Plant

at Eddystone, Pa.





Feed water at approximately 6500 psig will be provided by six CHTA pumps, operating as two half-capacity pumping units. Each pumping unit will consist of 3 pumps in series as shown above.

SCHEDULED to go on the line in 1959, Philadelphia Electric Company's 325,000 kw Eddystone Station will operate at a higher steam temperature and pressure than any installation thus far announced. Using supercritical pressure and two reheat stages, it will require less fuel per kw-hr than the most efficient power station now in operation.

The steam generator will be served by six Ingersoll-Rand double-case pumps. To provide the required pressure and capacity they will be arranged as two half-capacity pumping units each consisting of three pumps in series. The suction pressure will be 64 psig and the discharge approximately 6500 psig. The final discharge temperature is 575°F. Featuring Ingersoll-Rand's proven *Unit-Type Rotor Assembly*, these pumps will be the highest-pressure boiler feeders ever built. Special stuffing box designs will be used to control leakage at this supercritical pressure.

The selection of I-R pumps for this historic installation reflects the confidence of Philadelphia Electric Company in Ingersoll-Rand's ability to design and build equipment for pressures and temperatures never before encountered in boiler-feed service.

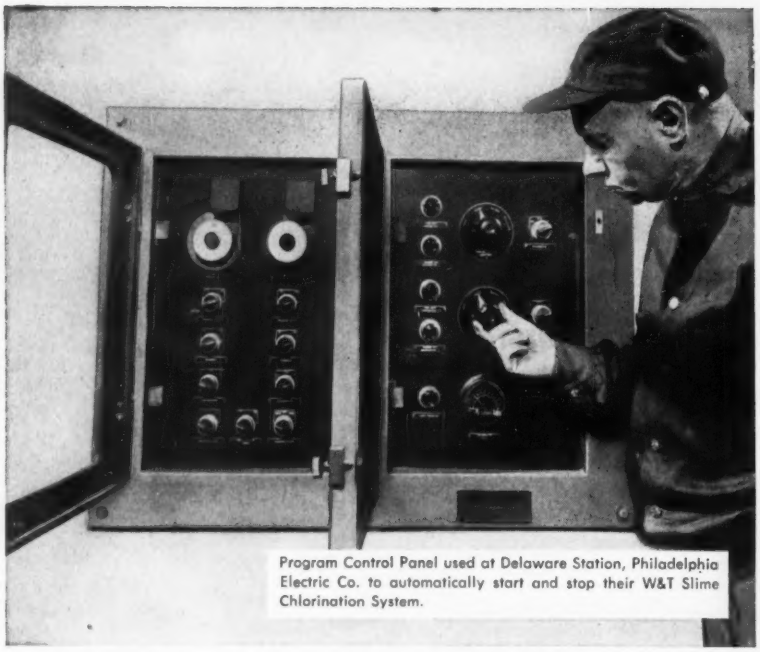
Whatever your boiler-feed requirements, they can be met to advantage with Ingersoll-Rand centrifugal pumps of proved dependability and economy.

Ingersoll-Rand

11 Broadway, New York 4, N. Y.

10-465

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES



Program Control Panel used at Delaware Station, Philadelphia Electric Co. to automatically start and stop their W&T Slime Chlorination System.

HOW W&T CHLORINATION

controls slime in power generating plants

The Philadelphia Electric Co. has W&T chlorination equipment installed in their steam-electric generating stations to prevent slimes from fouling the turbine condensers and lowering the efficiency of the units. Maintaining cooling efficiency saves enough fuel to more than pay for the treatment.

Chlorination is controlled from a W&T Program Control Panel like the one pictured. Operators preselect chlorine dosage and treatment times. Chlorination is started and stopped automatically in accordance with the preselected schedule. The result is positive slime control without requiring personnel to supervise each treatment and without the expense of chlorinating continuously.

For information about W&T Slime Control Systems write for Bulletin CD-42.

WALLACE & TIERNAN INCORPORATED

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

HOW TO DETECT 3 PARTS CHLORINE IN A MILLION PARTS AIR

New W&T Solvay Chlorine Detector*

detects as little as 3 p.p.m. chlorine in a continuous air-stream sample. Automatically sets off alarm at higher concentrations.

Write for Publication 50.118

WALLACE & TIERNAN
INCORPORATED
25 MAIN ST., BELLEVILLE 9, N. J.

I-55 *Manufactured under patent license from Solvay Process Div., Allied Chemical & Dye Corp.

COOLING TOWERS

Continued from page 190

line, an overflow line and an emergency overflow to the ground to direct excess water to some unobjectionable point of disposal.

Basin outlets have screens to strain out leaves, bugs or other debris that may collect. This avoids damaged pumps and plugged condenser tubes. Inspect screens regularly to see that they are not plugged up enough to restrict water flow or cause screen failure due to excessive pressure drop.

Material deterioration. Most cooling towers are built of wood and fastened together with copper nails and bronze or brass bolts and other hardware. Ordinarily redwood is used, but cypress and a few other decay-resistant woods have been utilized occasionally. After some years of service, wood deteriorates. This is caused by wear from the action of the falling water or by fungal, bacterial or chemical action.

Tower water is often kept at pH 8 to 10 to lessen tendency for corrosion of the condensing and service water system metal. But 7.5 pH would be more favorable for tower wood.

Hence there is considerable diversity of opinion as to the best overall water treatment conditions for a cooling tower system. This article will not attempt to cover the various treatment methods. Tower parts exposed to alternate spray and drying action may be subject to considerably higher pH and chemical concentrations. Wood delignification may result. This is shown by whitening and wasting away of outer wood surfaces.

Also, bacterial and fungal action may decompose the wood. This affects either the cellulose or the lignin. Severe "brown rot" is most often found in moist places next to iron bolts or washers. "White rot" is caused by decomposition of the lignin in the wood. But in "brown rot" the cellulose forming the wood cells and fibers is attacked and weakened.

It seems that tower parts not completely or continuously wet are most subject to decay. Partially-wet surfaces exposed to air and moisture are usually affected first. Spray eliminators, air louvers and trough tops are typical parts in this type of service. Completely wet or dry portions of a tower usually last longer.

There are various theories and practices for tower water conditioning to prevent or lessen deterioration. But as yet there is not a complete understanding of the subject. Each tower and water condition requires special consideration by a qualified water-treatment specialist.

Next article will consider cooling-tower fans, and go into tower operation.

1000 BRINELL DURACASE TRIM...

Stops galling and erosion

Since the introduction of OIC's Duracase Trim, many forged steel valve specs are obsolete. This 13% chrome stainless steel trim with 1000 Brinell, case-hardened wedges and discs assures positive protection against even the simultaneous attack of the three valve-destroying agents—corrosion, erosion, galling.

OIC offers you a choice of two modern body-bonnet connections—union ring or bolted bonnet—on its entire forged steel gate, globe, angle, and check valve line.

In addition, gate valves offer a choice of standard-flow or high-flow body ports, both with 1000 Brinell wedges.

Step up your valve requirements to the modern high-quality standards reflected in OIC valves. Include OIC on your next specification.

For OIC forged steel valve specification literature, write for Forms No. 195 and 195-R.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC VALVES | FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

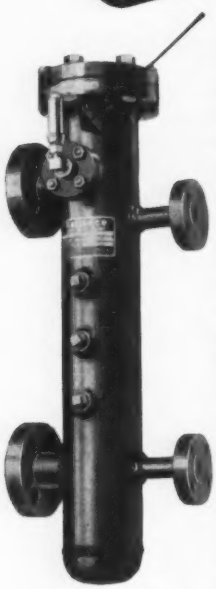
The Reliance Safety Team

Warns you of low or high boiler water

Prevents many a water level accident

SOUND CHECK ✓ ALARM Water Column

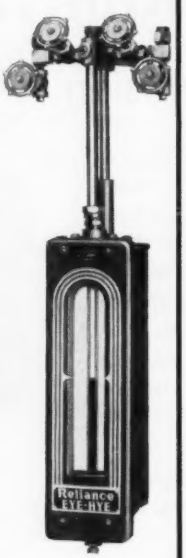
SIGHT CHECK ✓ EYE-HYE Remote Gage



It takes *Team Work* to prevent boiler accidents. No amount of *equipment* entirely offsets factors such as ignorance, carelessness and indifference on the part of operators.

It takes team work between men and devices to keep your plant safe. If your men can *hear* and *see*, their attention to the water level information supplied by the Reliance Safety Team will prevent boiler water level accidents.

The sensitive float-operated Alarm on the Reliance Water Column sounds a last-resort warning when water approaches low or high danger points. But for minute-to-minute scanning by operators, EYE-HYE beams its bright picture of true water level condition from its convenient eye-level position.



Avoid time-and-money-expensive low water accidents with the help of the Reliance Safety Team. Ask your nearest Reliance Representative, or write to the factory.

THE RELIANCE GAUGE COLUMN COMPANY
5902 Carnegie Avenue • Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

Reliance®

BOILER SAFETY DEVICES

Continued from page 146

the conductor in direction of current flow; your fingers wrapped around the conductor will point in direction of the flux.

In field of loose coil some of circular lines of force combine to form longer lines which pass through complete coil. When turns of coil are brought together to form a solenoid, nearly all the lines of force combine into loops passing through the center of the solenoid. Thus, the solenoid becomes a magnet with a north pole at one end and a south pole at the other. Now if an iron core is placed in the solenoid, the number of lines of force (strength of field) is greatly increased because of the lower reluctance of the iron. Iron core also serves to concentrate flux in useful area.

Magnetomotive force (mmf) is product of amperes in coil times number of turns in coil. Unit of mmf is the *ampere turn*. Flux depends on ampere turns of coil and reluctance of magnetic circuit. There are no commonly accepted units of reluctance, but if reluctance of air is taken as 1, reluctance of other substances can be expressed relative to air. Iron, steel, nickel and some alloys have reluctances sufficiently lower than air to be known as *magnetic* substances. Most materials have about the same reluctance as air; these are *nonmagnetic* substances. A few substances repel magnetic lines of force; these are *paramagnetic*. Some magnetic materials retain their magnetism after the magnetizing current is turned off, and can be used for permanent magnets. Other magnetic materials, used in most electromagnetic applications, lose most of their magnetism when the current is shut off.

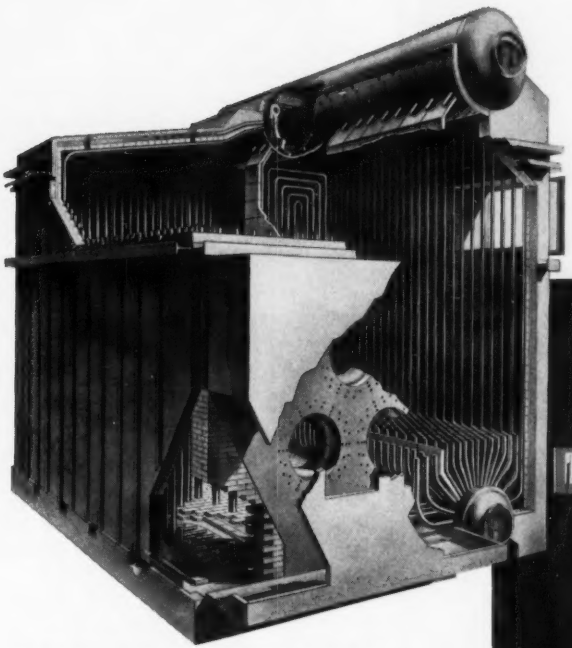
Magnetic field density is expressed in lines per unit area of cross section (at right angles to the lines of force). Field density (B) versus mmf (H) can be plotted as a curve for a given magnetic material. *Example:* lines per square inch vs ampere-turns. These curves are not straight lines, for reluctance of magnetic materials changes according to the field density in a manner that depends on the material's composition. Reluctance increases with field density and after a certain point —the "knee" on the B-H curve—you need many additional ampere-turns to get a little increase in flux. This condition is called *saturation*.

When rewinding dc coils (ac coils involve complications) keep in mind simple relationships of electric and magnetic circuits. *Example:* rewinding 230-v controller holding coil for oper-

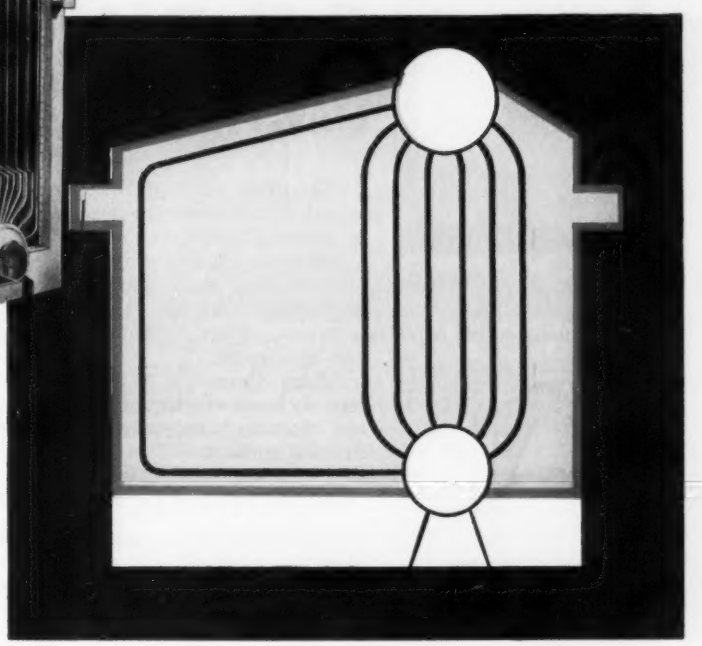
Another Feature of the FW Series "SC" Standard Boiler

PRESSURE-TIGHT CASING

permits
LOWER OPERATING COST
through
MORE EFFICIENT COMBUSTION



Cut-away view of Foster Wheeler "SC" Series Standard Steam Generator



OTHER FEATURES AT A GLANCE

- Completely water-cooled walls
- Over 19-foot firing depth
- Unrestricted circulation
- Fully drainable superheater
- Efficient convection surface
- Bottom supported unit
- Steam purifying system
- Full insulation

THE ALL-WELDED steel casing of the Foster Wheeler Series "SC" Steam Generator forms a rigid, pressure-tight unit which can be arranged for either pressurized or balanced-draft operation.

By eliminating all possible sources of air or gas leakage, this pressure-tight design increases combustion efficiency and contributes to higher fuel economy per pound of steam per hour. No sliding seals are necessary as the stationary casing is welded to the drums and the differential in expansion provided for by an integral horizontal expansion joint which encircles the entire unit. Pressure-tight ports are provided for observation of burners and flame.

These cost-saving FW Series "SC" Steam Generators are available in capacities from 50,000 to 150,000 lb/hr, for pressures to 1500 psi and superheated steam temperatures to 950F. For further information, write for Bulletin B-55-4. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

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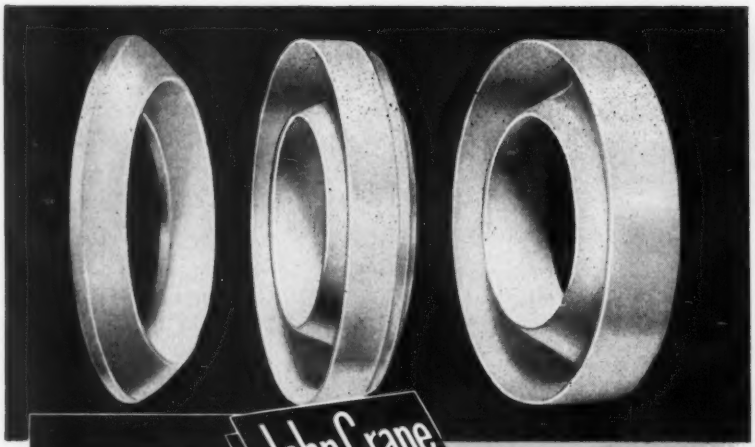

John Crane

CHEMLON *

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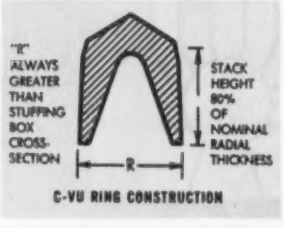
ARE INDUSTRY'S MOST UNIVERSAL PACKING . . .

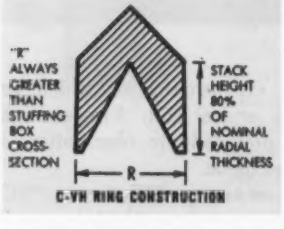
Countless successful applications of C-V Rings under the most severe service conditions have made this the closest approach to a universal packing.

It will effectively handle all industrial acids, alkalis, solvents, organic and hydraulic fluids . . . temperatures from −120°F. to +500°F. . . . is equally suited to valves, pumps, mixers, hydraulic cylinders and like equipment.

"John Crane" C-V Rings have extremely low coefficient of friction. "Breakout" friction is only slightly higher than running friction.



C-VU RING CONSTRUCTION



C-VH RING CONSTRUCTION

TWO STYLES ARE AVAILABLE:

C-VU RINGS *for low pressure service* —such as control and regulator valves handling gases and fluids, where it is necessary to have a very sensitive and resilient type packing.

C-VH RINGS *for high pressure service* —for use in pumps, hydraulic cylinders and like services at pressures ranging to 500 psi. and over. These rings are constructed with a heavy wall heel to withstand pressure requirements. They are designed to provide voids between rings, so that as the Teflon expands due to heat, this take-up room minimizes any excess friction in the stuffing box.

"John Crane" C-V Rings are available in full line of standard sizes and male and female adaptors. Sizes can be molded to stuffing box specifications.

Request Bulletin P-325.

*"John Crane" C-V Rings are made from Chemlon—*the best in DuPont Teflon.*

Crane Packing Co., 6436 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

John Crane

CRANE PACKING COMPANY

BASICS

Continued from page 194

ation on 115 v. You'll want to keep flux the same, therefore ampere turns must be the same. At half voltage (ratio of 115 to 230), you'll get half current, and half ampere turns. Reducing turns by one-half cuts resistance in half and current is original value, but ampere turns are now only half original value since turns were reduced by one-half. Therefore you've got to halve the resistance again to get double the current and maintain required ampere turns. The reverse would be true (twice the turns and half the wire size) if you were rewinding a 115-v coil for 230 v. *Next month: Generating an emf.*

MARMADUKE

Continued from page 148

—the bearings and the gear teeth.

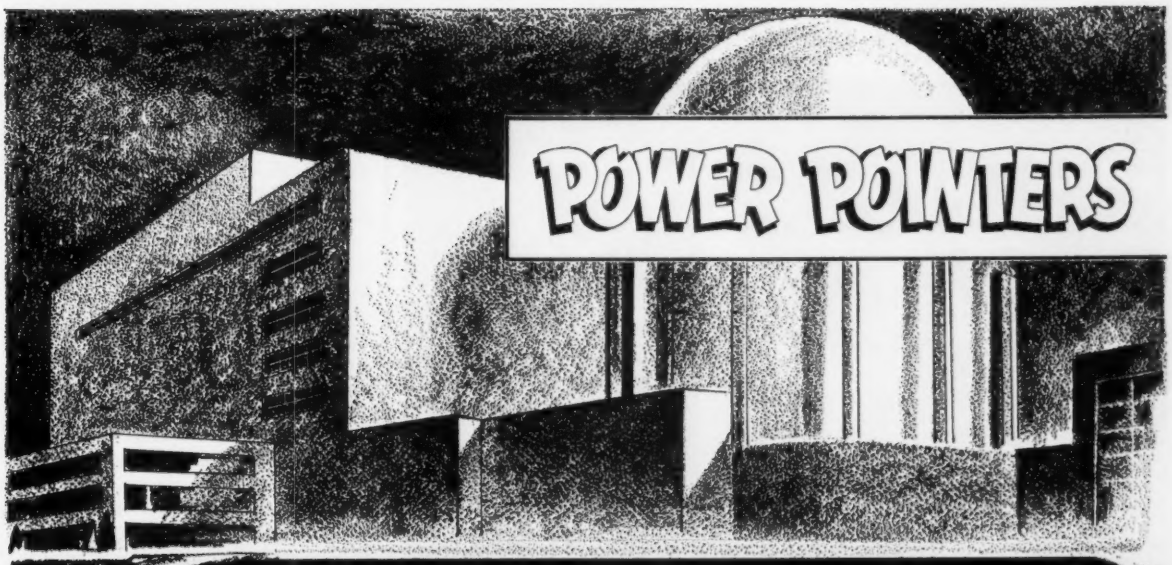
The super had sent an SOS to the pump manufacturer, but hadn't received a practical solution that could be carried out by the refinery's help. The manufacturer did send a long letter explaining what he thought caused the vibration.

Then the super contacted a leading consulting engineer in London. The consultant wrote a long letter, going into the theory of vibration. He pointed out that piping systems carrying fluid are near perfect conductors of noise and vibration. He explained that equipment at the piping's other end can fail repeatedly from such vibration. He felt some other machine at the refinery was the snake in the grass.

The English consultant had three recommendations. First, put vibration isolators under the source of vibration —once it was found. Second, isolate the piping system from the source of vibration with sections of flexible piping. Third, replace all the solid concrete anchors with flexible anchors under the large 8-in. diameter piping. The cost of all this would be plenty high if the super had the high-priced technicians out in that desert hole to do the job.

The letter went on to explain that rotating actions can't be perfectly balanced within a machine and vibration is measured in cycles per minute. Then followed a long discussion on disturbing frequency. "And once you know the disturbing frequency, you can always isolate it," continued the consultant cheerfully from his office in London.

But the letter cautioned: "The lower the natural frequency, the more effective the vibration isolation." Here the super was warned to keep in mind that



½ cubic yard of Atomic fuel will power city of 250,000!

BEFORE LONG, THIS MIDWEST ATOM POWER PLANT WILL GO INTO LIMITED OPERATION. BY 1960, IT SHOULD PRODUCE APPROX. 100,000 KW—ENOUGH ELECTRICITY FOR ¼ MILLION PEOPLE. ALL THIS FROM A REACTOR FUEL CORE 30½" X 30½" IN SIZE... NICKEL-CONTAINING ALLOYS HELP PERFECT SUCH REACTORS...STAND UP TO HIGH PRESSURES, CORROSION, SEVERE HEATS...IN PIPELINES, PUMPS, CONDENSERS, HEAT EXCHANGERS, FUEL TANKS. AND INCO NICKEL ALLOYS ARE GREAT PROBLEM-SOLVERS IN FOSSIL-FUEL AND HYDROELECTRIC PLANTS, TOO.

38 years in a sea-soaked manhole!

CABLE SPLICING CHAMBERS HELP SERVICE NEW YORK CITY'S TELEPHONES, TELEGRAPHS, STOCK TICKERS, POLICE AND FIRE ALARMS. HARBOR WATERS SEEP INTO MANY OF THEM EVERY HIGH TIDE. THAT'S WHY SUPPORTS AND RACKS ARE MONEL* NICKEL-COPPER ALLOY—THEY WITHSTAND CORROSION, HOLD CONDUITS RIGID, YEAR AFTER YEAR. LADDERS ARE MONEL, TOO—SOME ON THE JOB 38 YEARS!

7½-Mile "extension cord" sheathed in MONEL

SAN JUAN ISLANDS, OFF WASHINGTON STATE, GET ELECTRICITY FROM THE WORLD'S LONGEST UNDERSEA POWER CABLE...SHIPPED CROSS COUNTRY ON NINE FREIGHT CARS, WELDED AND CHAINED SO THEY COULDN'T UNCOUPLE. THE CABLE'S CONDUCTOR CORES HANDLE 25,000 VOLTS... ARE SHEATHED IN NON-MAGNETIC "403" MONEL TAPE. DESPITE A SALT-WATER HOME, IT'S EXPECTED TO LAST UNTIL 2001 A.D.

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WHERE CAN *YOUR* PLANT PUT THE CORROSION RESISTANCE, HEAT CONDUCTIVITY AND HIGH-TEMPERATURE STRENGTH OF MONEL TO WORK? PERHAPS OUR BULLETIN "ENGINEERING PROPERTIES OF MONEL" WILL HELP YOU FIND OUT. WRITE FOR A FREE COPY *NOW*.

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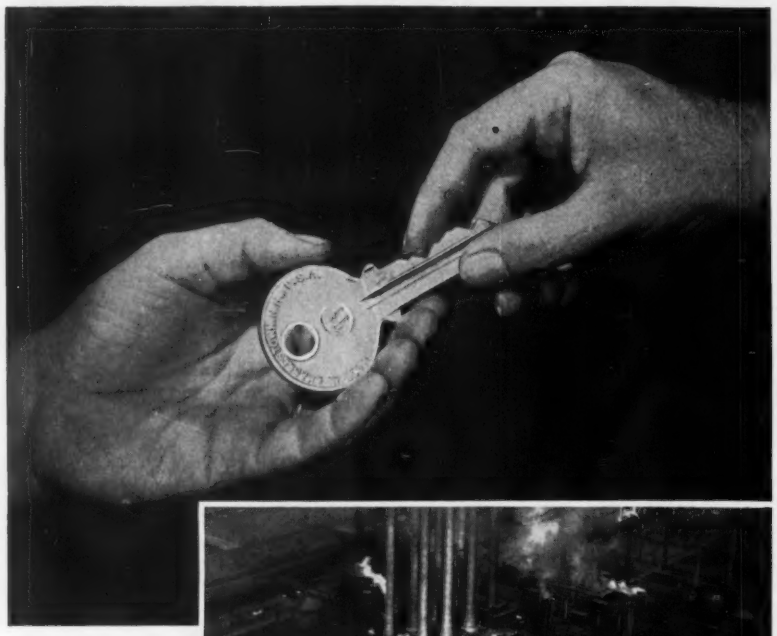
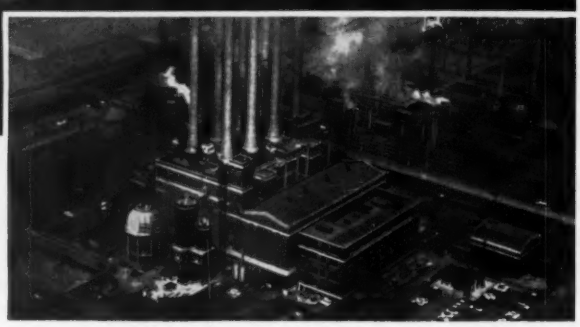
More POWER for *you*...with MONEL

WHY A TURN-KEY PROJECT IS BEST FOR YOU





Ford's Rouge Power Plant

A Turn-Key project is a "packaged" service that combines engineering and construction in a single contract . . . and that may include other services such as preliminary investigations, studies and site selection, procurement of materials and equipment, initial operation of the finished plant.

Advantages to you:

LESS COST: Who is better qualified to construct a project than the firm that designs it? In a Turn-Key project one organization performs both engineering and construction services; details are handled quickly, efficiently—therefore more economically.

LESS TIME: Excavation can be made and foundations started several months prior to the release of the Engineer's completed design drawings and specifications. Construction follows blue prints—promptly. This scheduling of design and procurement to meet construction requirements permits the project to advance in an unbroken sequence—setting the stage for a faster delivery of the completed plant.

MORE SERVICE: One contract gives you *complete* service—no question about responsibility. Thus you have better control and more closely integrated planning.

We offer you engineering and construction services separately but suggest you consider combining them into a Turn-Key project that will save you both time and money. Write today for this free booklet describing the advantages in detail.

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MARMADUKE

Continued from page 196

the disturbing frequency should always be two and a half times more than the natural frequency. "And for critical installations, the ratio should preferably be four to one," the letter ended sagely.

All this was double talk to a man several thousand miles away who knew nothing of vibration and only wanted a practical solution. If anything, that letter got the super more confused than ever. He heard about Marmaduke Surfaceblow from the chief engineer of an American tanker loading crude oil at the refinery. The chief assured him that Marmy had an uncanny way of ironing out knotty problems. Because the super wanted results and not words, he airmailed the English consultant's letter with blueprints of his piping system to Marmy, offering to pay his expenses to the Middle East and back.

A week later, the super called Marmy from Paris, while there on business. That's where we started this story. Over the phone, the super again made the unusual offer of flying Marmy out to Irubaak to tame those two pumps. That's when Marmy said he could do it by phone.

Naturally, I was interested to know how Marmy expected to solve a ticklish vibration problem 6500 miles away without inspecting it personally.

"You don't need any highbrow consultants and their longhaired theory to brainwash those neurotic pumps," roared Marmy, loud enough to be heard in Paris without a telephone.

"Sure, I know all you got out there is a lot of barefooted natives who don't know a pump from a lathe . . . you don't have to tell me they know nothing about vibration," he bellowed in his bullfrog voice. "But don't let that worry you. Neither do a lot of experts, when it comes to nailing down dancing machinery. I'll tell you how your boys can lick that problem without knowing anything."

After more talk from the Paris end, Marmy blasted away again. "And how much do you think it'll cost to fly to your refinery? Yeah? If you figure my expenses and fee at $4000, just send me half of that and do like I say . . .OK? —it's a deal. Now listen carefully . . . just have two of your barefoot boys split that concrete foundation down the middle between the two pumps. All they need is a 2-in. diameter star drill, a heavy hammer and strong arms. But make sure the split is complete so there are a few inches of space between those two foundations. Then after you're satisfied your pumps are OK, send me a check for two thousand bucks. Use the other two thousand smackers to show

Inside Story on POWELL VALVES for POWER PLANTS

On the outside, valves may look alike. However, on the inside there can be a big difference -- in the metal itself, in design, in manufacture. And the inside story on Powell Valves for Power Plants is that every valve has PERFORMANCE VERIFIED.

In the manufacture of Powell Valves, only the finest available materials are used. And painstaking quality control is rigidly enforced through each and every step of manufacture. Every part of every valve must pass rigid inspection.

As a final step in manufacture, every Powell Valve is subjected to an ACTUAL LINE TEST. Because of Powell's quality control, valve failure is practically unknown. Records from the world over prove it.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our COMPLETE quality line which has PERFORMANCE VERIFIED.

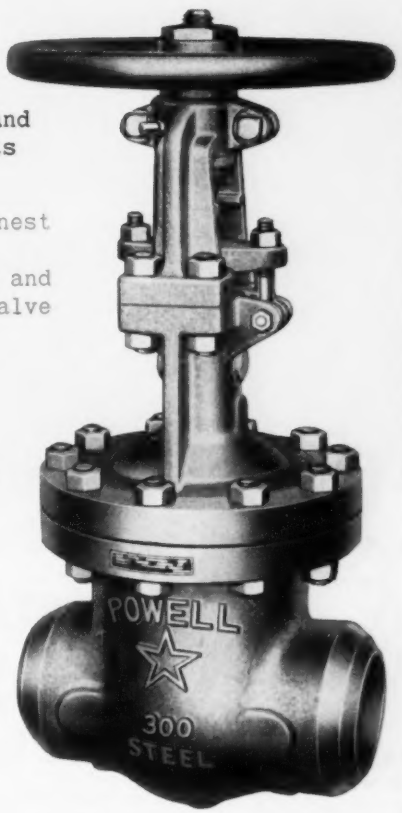

FIG. 3003WE -- Steel O.S. and Y. Gate Valve for 300 Pounds W.S.P.

FIG. 1561WE -- 150-Pound Steel Swing Check Valve

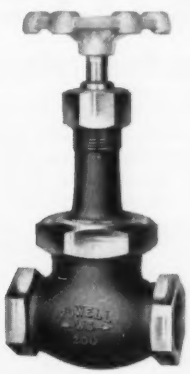

FIG. 2608 -- Bronze "W.S." Full Flow Globe Valve for 200 Pounds W.P.

PERFORMANCE PV VERIFIED

The Wm. Powell Company, Cincinnati 22, Ohio . . . 111th YEAR

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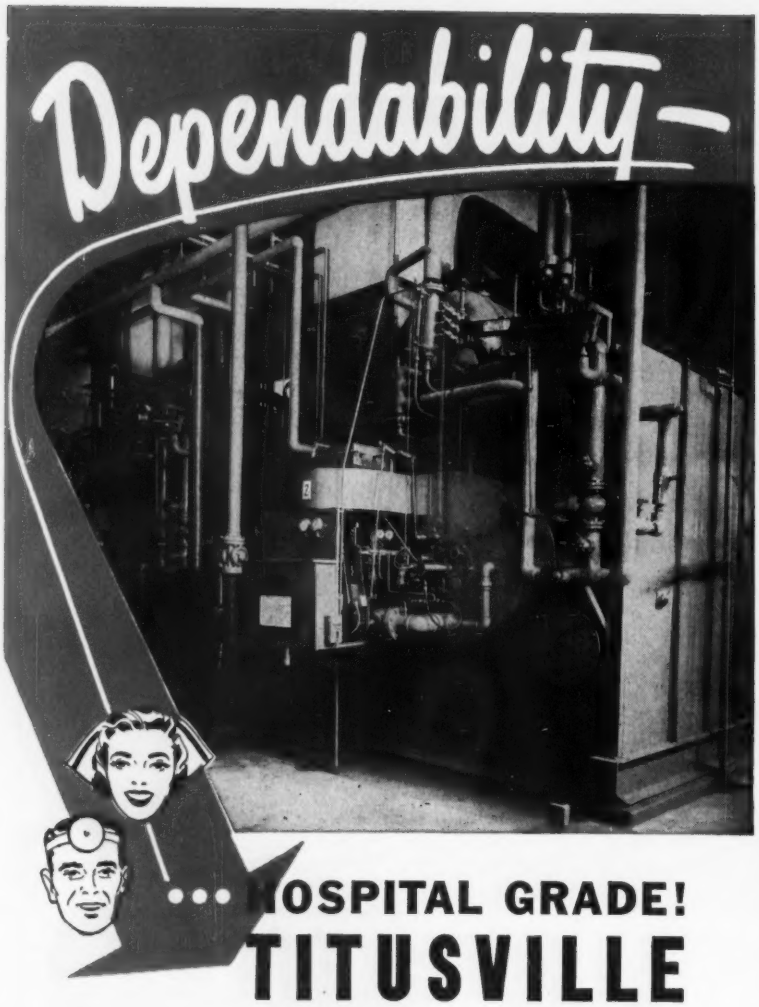
BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES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MARMADUKE

Continued from page 198

yourself a good time in Paris. If you don't know where to go, spend it at Le Rat Mort up in Montmartre, or go to Au Belle Poulet on Rue Turbigo—those are nifty joints. Now forget about those pumps." With that Marmy hung up. He revved up his induced-draft fan and sent another cloud of eye-stinging cigar smoke into the room. I shoved off for my office.

Just a few minutes ago, my phone rang here in our POWER office. Bedlam called me from the Bent Propeller Bar over in Hell's Kitchen. He informed me that Marmaduke had just navigated into his establishment and was flashing a two thousand dollar check from the Khuuzistan Oil Co. So now, six weeks later, it turns out that Marmy had the right formula to cure those two dancing pumps. And all it took besides his high-pressure practical engineering was a hammer and chisel on the other end.

—SME

Marmy's Mailbox

'Tis here you exchange blasts with the old boy

100TH STORY OK

Marmy is a character synonymous with the lumberjacks' Paul Bunyan and the cowboys' Pecos Bill. Exception is that his stories have a strong element of practical truth. I'm sure that readers, including myself, are grateful for this admirable individual.

Only thing missing in the photograph of his desk top in his 100th story is a pair of size-16, triple-E brogans with his feet in them.

H M NEUHAUS *Philadelphia, Pa.*

LIKES MARMY'S BOOK

Today I received my first copy of *The Marmaduke Story*. Having been associated with merchant mariners during the war at the U.S. Merchant Marine Academy, and now manufacturing boilers, I thoroughly enjoy his stories.

J LEGG *Midland Park, N. J.*

MARMY AND GLENCANNON

Has Marmy ever encountered Colin Glencannon, chief engineer of the HMS *Inchliff Castle?* In all their travels, surely those two must have crossed trails. That would be some story. Send me two copies of Marmy's book.

S P KASTELIC *Evansville, Ind.*

EXTRA HEAVY DUTY

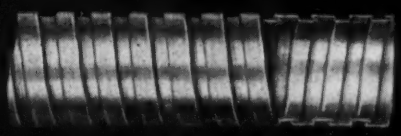
HEAVY DUTY

LIGHT DUTY

MEDIUM DUTY

PENFLEX

LIGHTWEIGHT EXHAUST



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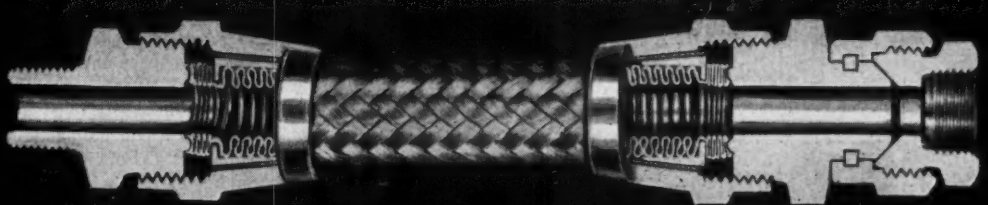
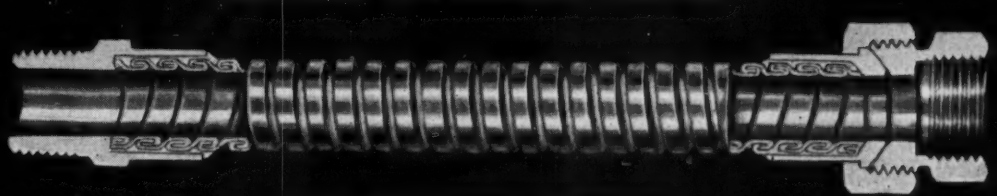


PENFLEXWELD WITH HEATPROOF COUPLINGS



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A complete laboratory analysis of your water will enable us to prescribe the correct Deady Chemical Products, laboratory-fitted to your special water problems.

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Memphis, Tenn.
Chattanooga, Tenn.

PERFORMANCE CURVES

Continued from page 85

turbine heat rate versus generator output for values of constant circulating-water temperature. This was derived from a cross plot of Fig. 4. Example 1 furnishes the data for the "horizontal" load lines correlating heat rejection and turbine-generator heat rate in Fig. 4. Then from Fig. 1, at each circulating-water temperature and respective kw load, read the corresponding heat rejection and plot these (circled points) on Fig. 4. Lines of constant circulating-water temperature (dashed curves) may be drawn through these points, but they are not needed.

The plotted points on Fig. 4 correlate the heat rate, load and circulating-water temperature. These furnish the data for plotting Fig. 6. This is the combined turbine-generator and condenser performance in a convenient form for checking actual performance or for evaluating operating costs.

H-T WATER

Continued from page 79

economical zoning arrangements. Another criterion for zoning is the number of main distribution lines of different lengths to be served by different pumps. This plan can simplify flow control.

It's relatively easy to plot cost of a distribution line per unit capacity for various temperature drops. Cost of furnishing heat, naturally, depends on temperature drop. You'll need, for example, about twice as much fluid for a 200-F drop as for a 100-F drop. So, for maximum economy, systems should have high-flow temperatures, low-return temperatures. This is especially important in large-capacity systems. *Reason:* Cost of furnishing heat for larger pipe sizes climbs much faster than the corresponding size increase.

Heat-exchanger design is an important factor affecting economy of h-t water installations. You can generally cut costs by boosting heat-exchanger size rather than increasing pipe size and pump capacity. Also, water-coil velocities shouldn't exceed 8 fps.

Heat consumer types. Direct methods of h-t water heating use h-t water coils, radiant panels. Indirect systems deliver heat energy of h-t water to l-t water or steam.

Simplified distribution circuit, Fig. 3, p 79, shows common heat exchangers. Unit heater, radiant panel and forced hot-air heater make use of steam and water as secondary heat carriers. Quantity of h-t water you'll circulate through the heat-exchanger tube bundle is con-

KAW uses KEY* ...the dependable welding fitting

KEY-KAST Ells, Caps, Tees and Reducers on Main Steam Service at Kansas City (Kansas) Power Station

Like so many other power plants, the new Kaw Power Station of the Kansas City (Kans.) Board of Public Utilities chose rugged, dependable KEY-KAST welding fittings for its steam lines.

The long life and superior performance of KEY-KAST fittings are achieved through careful engineering and close quality control, with special emphasis on—

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JOB DETAILS

User: Board of Public Utilities—Kansas City, Kansas
Customer: The Flori Pipe Company
Consultant: Burns & McDonnell
Fabricator: The Flori Pipe Company
Fittings: 2½", 6", 8", 12" Schedule 80 and 100 Ells, Welding Caps, Tees, and Reducers
Material: 1¼% Chrome, ½% Moly, Grade WC6
Service: Main steam
Conditions: 900 PSI @ 900° F.

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KEY RETURN BENDS AND FITTINGS

W-K-M THROUGH-CONDUIT GATE VALVES

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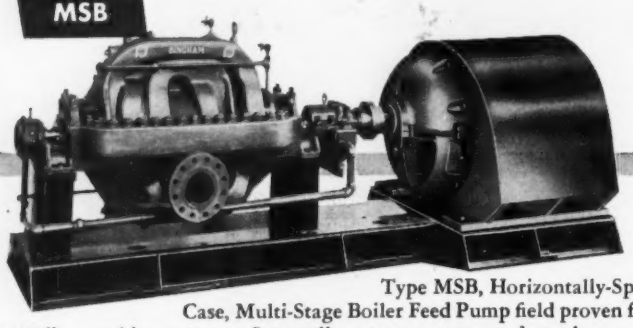
Specify

Bingham

"DOUBLE VOLUTE"
BOILER FEED PUMPS

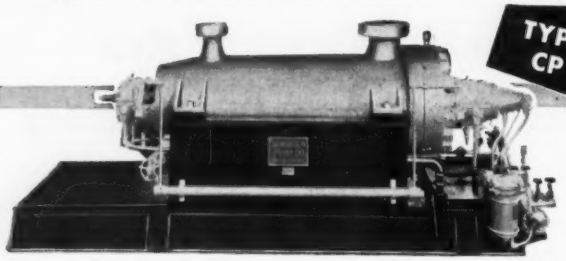
for the ultimate in dependability
IN HIGH PRESSURE SERVICE

TYPE MSB



Type MSB, Horizontally-Split Case, Multi-Stage Boiler Feed Pump field proven for 1200 lbs. working pressure. Integrally cast cross-overs and evenly spaced case bolting located uniformly close to the shaft center line, enclosing a minimum pressure area, eliminate case distortion and inter-stage jetting.

TYPE CP



Type CP, Multi-Stage, Double-Case Boiler Feed Pump with forged outer barrel for high pressure service.

All BINGHAM Boiler Feed Pumps feature: (1) "Double Volute" construction, resulting in full radial balance of the rotating element *throughout the entire operating range of the pump.* (2) Double suction first stage for low NPSH. (3) Balanced axial thrust (no balancing drums needed). (4) Kingsbury Thrust Bearings. (5) Stuffingboxes subjected to suction pressure only. (6) Design for High Speeds.

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H-T WATER

Continued from page 202

trolled by a temperature- or pressure-control instrument that positions a valve in the hot-water return piping from the heat exchanger.

Steam producers can generate steam at any pressure—only limitation is temperature of the h-t water available. Important point: Steam separator is essential for dry steam.

Radiant coils and panels making direct use of h-t water must be more than 10 ft above floor. It's an excellent way to heat warehouses, factories, hangars.

My biggest boner

The day that I signed on a liberty ship during World War II as second-assistant I walked right into a boiler inspection. On hand were the chief, the boiler inspector, marine superintendent and other top brass, plus the shore gang who were tearing up the engine room. And to make life more interesting, the ship's wipers had set up scaffolds and were painting the room. That ship had the hp end of the big triple-expansion steam engine only a few feet from the two water-tube boilers, with no bulkhead between them. One scaffold reached from the hp cross-head to the steam drums and was loaded with paint cans and wipers swinging their paint brushes.

Auxiliary steam line for the electric generators had stop valves on each steam drum and manifold above the main engine. After the inspector set the safeties on the port boiler, he asked me to switch it out and cut in the starboard boiler. I closed the main manifold valve to the port boiler and opened the starboard valve. But the drum stop was closed, causing the electric generator to come to a stop. The engine room got very dark.

I dashed to the starboard boiler to open the drum stop, but in the darkness got mixed up with the wipers and their paint cans. Cans went flying, paint splattered everyone.

Well, that ship was booked for the South Pacific and I had just returned from there on another ship. A few hours later, as I walked down the gangplank with my packed bag, I consoled myself with the thought that the South Pacific wasn't such a hot run after all.

S H KRONE *Canby, Minn.*

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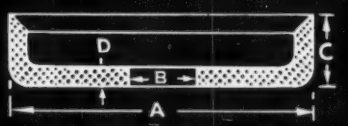
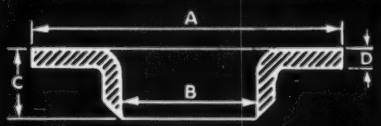
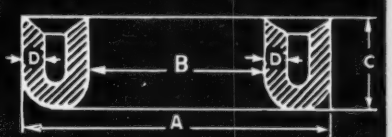
from accurately dimensioned molds to assure BETTER SERVICE!



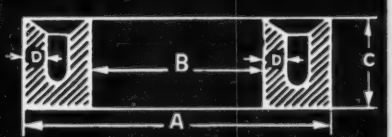
"CUP" Shaped



"FLANGE" Type



Round Bottom (R) "U"



Flat Bottom (F) "U"

"U" Shaped

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Anchor molded cups, flanges and "U" packings are formed in accurately dimensioned molds, made with special compounds ranging from natural rubber to the most appropriate synthetic rubber, all assuring long life and low friction.

Molded parts are used on a variety of equipment, packing against oil, solvents, air, water, gasoline.

Style 11 is made from strong cotton duck frictioned with an oil and solvent resisting compound. Recommended for high pressure oil, water, gasoline, etc., on presses, pumps, clutches, welding equipment, lifts, jacks, etc. Also on air where rapidity of stroke will require packing with a low coefficient of friction.

Style 43 Flexible type is a softer grade — better where flexibility is essential. Recommended for equipment requiring a very sensitive packing to insure a positive seal on air, oil, water, etc. . . . also recommended for equipment with mechanical irregularities such as slightly worn, scored, and remachined cylinder rods.

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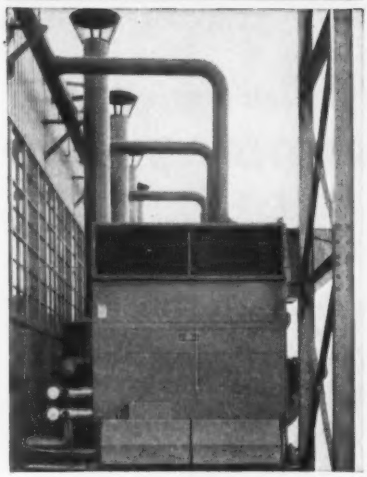

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KINETIC THEORY

Continued from page 89

force F_1 for a very short time t_1. To get a continuous force F acting on the wall we must have a continuous stream of n molecules per sec hitting in succession so that $t = t_1 + t_2 + t_3 + \ldots + t_n = 1$ second. Then since:

$$t_1 = 2mv_1/F_1;\ t_2 = 2mv_1/F_2;\ t_n = 2mv_1/F_n$$

and $F = F_1 = F_2 = F_3 = \ldots = F_n$ it follows that:

$$t = \frac{2mv_1}{F_1} + \frac{2mv_1}{F_2} + \frac{2mv_1}{F_3} + \ldots + \frac{2mv_1}{F_n} = \frac{n2mv}{F}$$

or, since $t = 1$ second

$$F = n2mv \qquad (13)$$

Actually we could have the stream of molecules come so that the force on the wall would fluctuate and then over a period of time we could calculate an average force. In practical cases there are billions of molecules hitting a wall section continuously and at random. This causes very minute fluctuations. These are so small, however, that our most sensitive pressure gages can't detect them.

So far we have considered motions and forces acting along a common straight line. Figure 4*b* and *c* show molecules hitting a wall at an angle other than perpendicular. The angle of rebound of the molecule equals the angle of impact in all cases. The only component of velocity that contributes to producing force on the wall is the component perpendicular to the wall, v_p. The component parallel to the wall plays no part in force production, but equals the parallel component of the rebound velocity in size and direction.

Gas pressure. We're now ready to develop the kinetic theory, as it was initiated by Joule in 1847. Let's study the behavior of one molecule, Fig. 7, bouncing back and forth between two parallel walls in a cubical container with side dimensions d.

When the molecule moves with the velocity $v = s$ ft per sec, it makes $s/2d$ round trips in one second. This allows it to make $s/2d$ hits on each wall per second. The area of each wall is d^2. In equation form:

$v/2d = n$ impacts per second against each wall

Then average force against each wall is:

$$F = n2mv = \frac{v}{2d}2mv = \frac{mv^2}{d}$$

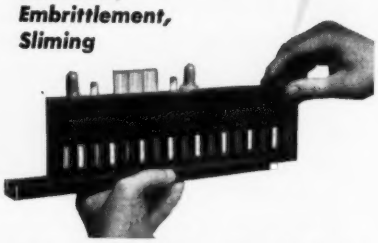
Since we figure pressure as the force per unit of area:

$$P = \frac{F}{d^2} = \frac{mv^2/d}{d^2} = \frac{mv^2}{d^3} = \frac{2}{d^3} \times \frac{mv^2}{2}$$

This equation shows that the pressure

fast, accurate tests for pH, PHOSPHATE, NITRATE with TAYLOR COMPARATORS

Help Control Scaling, Corrosion, Embrittlement, Sliming



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SEE YOUR DEALER for Taylor sets or immediate replacement of supplies. Write direct for FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Illustrates and describes full Taylor line.

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O-B VALVES

for quick "take down"

When lost production time sends unit costs skyrocketing, quick valve "take down" can be a money saver.

Joints on all O-B bronze valves are lubricated at the factory. Months after they are installed they can be readily "broken" for inspection or disc replacement.

If lost maintenance time is your headache, you'll want to see your distributor about O-B bronze valves—globe, angle, gate or check, or write to Ohio Brass Company, 380 North Main Street, Mansfield, Ohio.

4721-V

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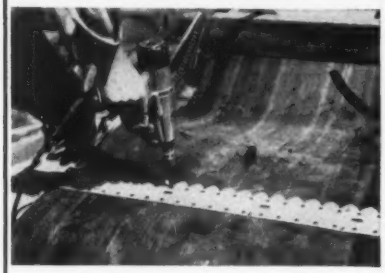
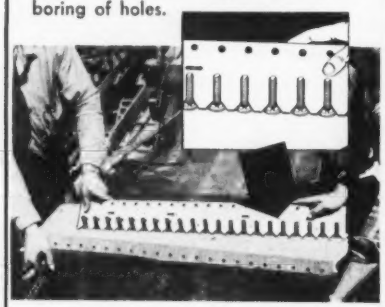
FLEXCO
POWER TOOLS
CUT APPLICATION TIME
IN HALF

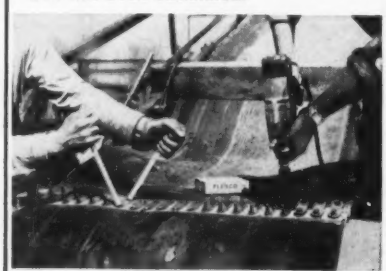
Your two man belt team can now join a belt 30" wide in 15 to 20 minutes . . . using the new FLEXCO Power Tools.



The FLEXCO Power Tool Boring Bit used with electric or air impact tool speeds boring of holes.



New FLEXCO Templet positions bolts for quick joining of belts. Reaching under belt has been eliminated.



Running down nuts is fast with the new FLEXCO Power Wrench used with electric or air impact tool. Two Bolt Breakers are used together to complete the joint.

If you are interested in speeding up fastener application, order the new Power Tools from your local FLEXCO Distributor. Write for Bulletin F-112-A.

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KINETIC THEORY

Continued from page 206

is directly proportional to the kinetic energy of the molecule or to the mass of the molecule and the square of its velocity.

We can easily recognize that the pressure will also depend on the number of molecules colliding with the walls, in fact the pressure is directly proportional to the number of molecules in the container, N.

From experience we know that the pressure on all walls of a container will be equal. This shows that the molecules ,while moving in complete chaos, nevertheless, distribute themselves to produce an even pressure effect on the walls.

In light of the even pressure, let's consider the direction of molecular movements in the body of the gas. Fig. 8 shows three different velocity vectors OV of the infinite possible number of directions. While these molecules move in all possible directions, the only components that produce pressure on the walls are those perpendicular to the walls. In Fig. 8 each of the velocities have been resolved into components perpendicular to the six walls of the container, OX, OY and OZ.

In an entire mass of gas of N molecules the *average* of components OX, OY and OZ must all be equal since the pressures on the walls are equal. Then the kinetic energy of the N molecules must be divided equally (on the average) between the *three* pairs of facing walls since the energy depends directly on the velocity components of all N molecules perpendicular to the wall, or $P \propto 1/3KE$.

Velocity averages. If v^2 is the average of all the squares of individual molecular velocities for N molecules:

$$v^2 = \frac{v_1^2 + v_2^2 + v_3^2 + \ldots + v_N^2}{N} \quad (14)$$

Then the total pressure on any wall area is:

$$P = \frac{N}{3} \frac{2}{d^3} \frac{mv^2}{2}$$

Now d^3 is the volume of the cube and Nm is the total mass of the gas then the specific volume is

$$V = \frac{d^3}{Nm}$$

So

$$P = \frac{2}{3} \frac{1}{V} \frac{v^2}{2} \quad \text{or}$$

$$PV = \frac{2}{3} \frac{v^2}{2} = \frac{v^2}{3} \quad (15)$$

Comparing the last equation with the general gas equation $PV = RT$ we can conclude that $RT = v^2/3$. Since R is a constant depending on the gas only we can conclude that *temperature measures the averaged square of the molecular velocities* and no other factor, see

Yes...
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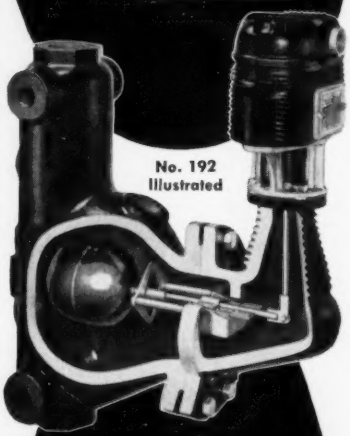
FOR BOILERS
TO 250 psi.



No. 192
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McDONNELL
92 SERIES
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Here's a whole new concept of control design and performance . . . with the best-known name in its field. Introduces repulsion magnetic switching, for positive opening and closing. Beats the heat as never before—okayed for 75° C. (167° F.) wiring. Has extra generous float clearances; operating levels that are not affected by pressure changes; and a host of other refinements.

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Shows 92 Series models with or without integral water column. Has full engineering data for controlling pumps or electric valves on boiler or tanks, for low water cutoff and alarm, etc.

Also shows companion 91 Series, for pressures to 150 psi.

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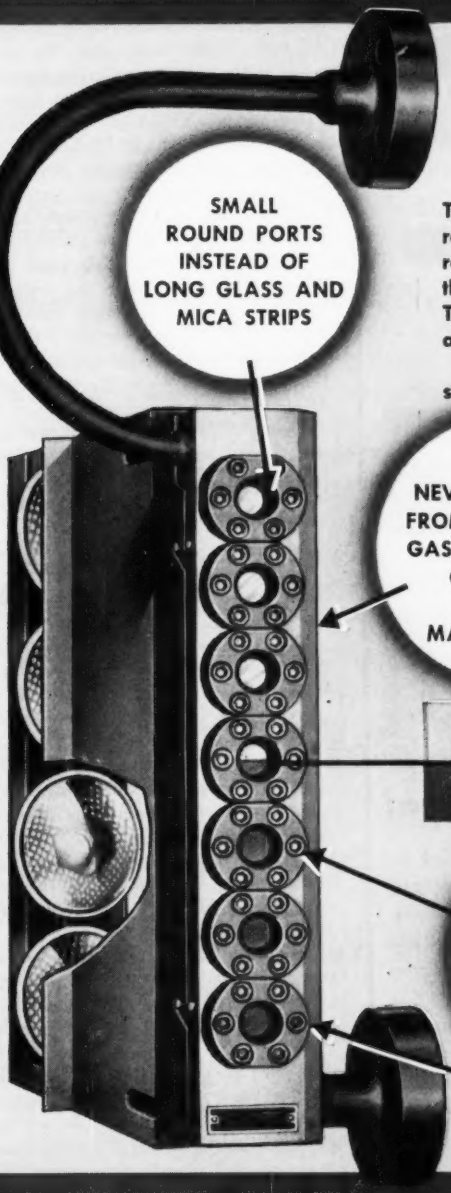
Boiler Water Level Control

MAKING Great Savings in GAUGE MAINTENANCE

(BOTH TIME AND COST)

DIAMOND "Multi-Port" BI-COLOR GAUGE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STEAM SHOWS RED
WATER SHOWS GREEN
COMPLETE PORT CHANGE REQUIRES ONLY ABOUT 15 MINUTES
EACH PORT THERMALLY INDEPENDENT

The Diamond "Multi-Port" Bi-Color Gauge makes startling reductions in maintenance costs. In cases where accurate records have been kept, labor and material costs are less than 1/5 the maintenance of conventional open port gauges. This is due to the unique design . . . note particularly the advantages that are pointed out on the photograph.

The "Multi-Port" operates on the Bi-Color principle . . . steam always shows red . . . water always shows green. There can be no question of water level. The gauge has been in continuous successful high pressure operation for more than three years in leading central station plants. Users report excellent readability and exceptionally high availability as well as important reductions in maintenance. Return the coupon below to get a copy of Bulletin 1174.

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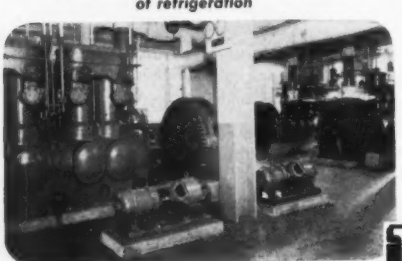
Refrigeration

Installed in Huge Brewery in Montreal

Evaporative condenser handling 330 tons of refrigeration



Three of four compressors using 1800 horsepower

Dow Brewery, established in 1790, now has a yearly output of over 1½ million barrels. Frick refrigerating equipment, including compressors, condensers, brine coolers, and carbon-dioxide liquefying system, was selected for an important expansion modernization program. Installation by J. H. Lock & Sons, Ltd., Frick Distributors in Toronto.

For the utmost dependability—whether on air conditioning, ice making, quick freezing, or other refrigerating work—specify Frick equipment.

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.

KINETIC THEORY

Continued from page 208

equation (14). By taking the square root of this average square we get from (14):

$$v = \sqrt{\frac{v_1^2 + v_2^2 + v_3^2 + \ldots + v_N^2}{N}}$$

v is called the root-mean-square velocity. It is higher than the average velocity of all the molecules.

Velocity distribution. This development is based on the root-mean-square velocity of the molecules. We might jump to the conclusion that at any given temperature all the molecules have the same velocity. This is not true—in fact, if all molecules could be brought to a common velocity, differing only in directions, they would immediately acquire a wide range of speeds all the way from zero to almost infinity.

To understand why this must be so let's study Fig. 9*a*. Here two molecules of the same mass approach each other and collide. A line connecting the centers of m_1 and m_2 is coincident with direction of travel of m_1 and exactly at right angles to line of travel of m_2.

Equation (12) showed that molecules in collision simply exchange velocities in their direction of travel. In Fig. 9*a*, m_2 has zero velocity in the direction of motion of m_1, so m_2 acquires all m_1's velocity, which is v_1, and gives none in return to m_1. This means m_1 comes to a dead stop so that $v_2 = 0$ as shown in Fig. 9*b*.

Molecule m_2 now has the vector sum of its own original velocity u_1 and v_1 which gives it a leaving velocity of u_r. Since $u_r^2 = u_1^2 + v_1^2$ we can see that m_2 acquires all the kinetic energy originally held by both m_2 and m_1. Fig. 9*b* shows the molecules after collision. Fig. 9*c* and *d* show what happens when m_2 hits m_1. Their roles are just reversed.

If a molecule like m_2 is hit at right angles several times in succession it will acquire very high velocities and energy and leave zero-energy molecules in its wake. So obviously there must be a wide range of velocities in any group of gas molecules. Fig. 10 shows the more general type of collision between molecules. The left-hand collision picture gives the vector diagram for computing velocity exchange. The right-hand diagram shows conditions in place before and after collision. To keep these exchanges in proper perspective don't forget that at atmospheric pressure and temperature any one molecule suffers *billions* of collisions per *second*. On the average they travel extremely short distances, so we are not aware of all this activity.

To measure this velocity distribution Maxwell and Boltzmann in the middle 1800's made a statistical analysis of

How Aitkin Light Plant came to choose STANODIESEL Oil M

Case story of exceptional results obtained with Standard Oil diesel lubricants

Because of plant operating conditions and generator capacity installed, Aitkin, Minnesota, Municipal Light and Power Plant had to operate a 1,235 H.P. Worthington engine over 38,000 hours before it could be taken out of service for complete overhaul. During that time, 19.2 million K.W.H. were generated. STANDARD HD Oil, predecessor to STANODIESEL Oil M was the lubricant.

When the engine was overhauled, all pistons were in good condition. All rings were free to move in ring grooves. There were no scars on cylinder liners. Piston walls were bright, wear was even. Based on this performance from STANDARD HD, plant management converted to the improved new oil—STANODIESEL Oil M—at the time of overhaul. STANODIESEL Oil M has been giving top performance ever since.

STANODIESEL Oil M is made from highest quality base stock. Additives help the oil resist viscosity change and keep parts clean. Other additives control foam, keep highly stressed parts lubricated.

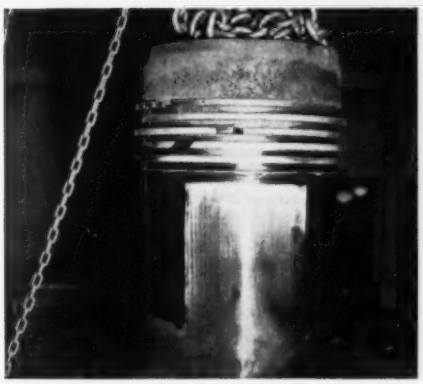
Get more information about STANODIESEL Oil M from your Standard Oil industrial lubrication specialist. There is one near you in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY
(Indiana)

STANDARD

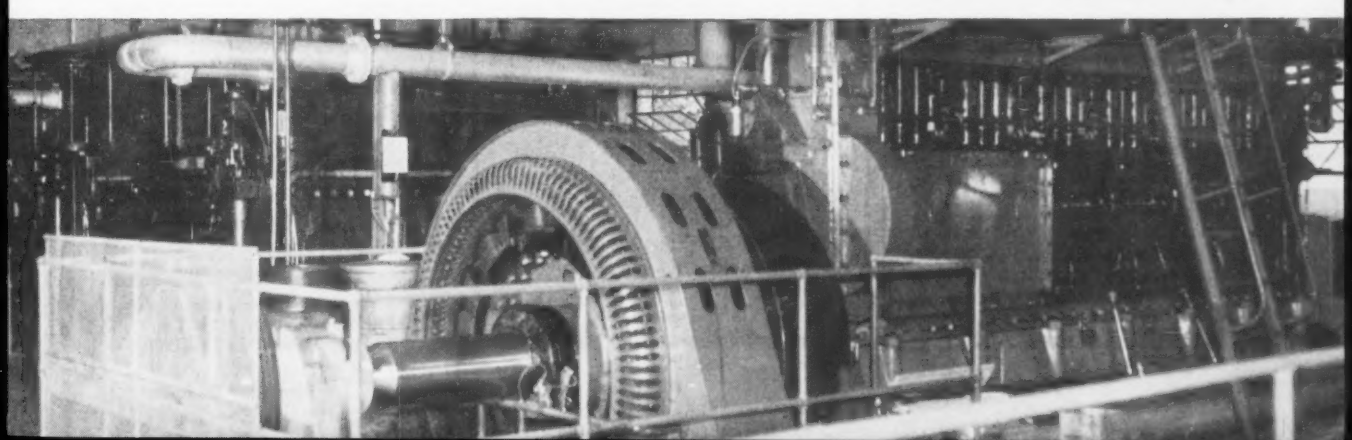
John Acklestad, Aitkin plant superintendent, and Carl Klenner (left) Standard Oil industrial lubrication specialist check engine service record. Carl has been rendering technical service on lubrication problems at Standard Oil for eight years. He has a degree from the Michigan College of Mining and Technology and has completed the Standard Oil Sales Engineering School.

"As is" photo of piston removed from engine after 38,000 hours of service. Rings were free.

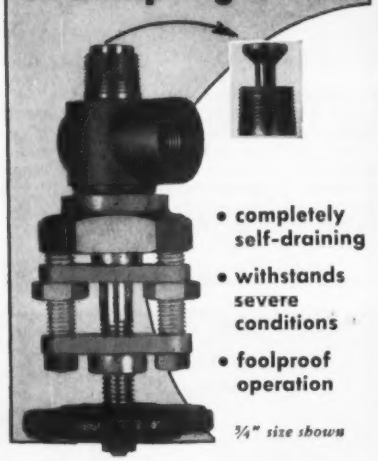


Quick facts about
STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult to lubricate areas and parts.
- Eliminates spark plug fouling in spark ignited gas engines and reduces combustion chamber ash and deposits in engines burning natural gas, LPG and liquid fuels.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil commingle.



New!
Jerguson Drain or Sampling Valve



- completely self-draining
- withstands severe conditions
- foolproof operation

¾" size shown

The new Jerguson No. 23 Drain or Sampling Valve is completely self draining, for the valve stem seats on the outside of the valve body. It is ideal for installations where it is desirable to have the valve seat inside the wall of a vessel in order to prevent the typical condition of liquid remaining in the nipple and valve inlet.

This rugged, new Jerguson Valve has outside screw and yoke construction to meet high temperature or corrosive conditions where inside threads cannot be tolerated. The efficient outside thread design eliminates possible freezing and allows the valve stem to work freely at all times. The No. 23 Valve provides foolproof operation because the stem is constructed with a left-hand thread, thus allowing the valve handle to operate in the normal direction of standard valves.

Available in sizes from ¾" to 2" N.P.T. ¾" and 1" sizes are recommended for pressures of 4000 lbs. @ 100° F. and 1000 lbs. @ 750° F.; 1¼, 1½ and 2" sizes are recommended for 600 lbs. @ 100° F. and 250 lbs. @ 750° F. Optional features include construction with additional outlet for such uses as a steaming out connection and with a reamer on the end of the stem to break away encrusted matter which may have collected on the inside vessel wall.

Write for data unit and complete details.

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100 Fellsway, Somerville 45, Mass.
Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

KINETIC THEORY

Continued from page 210

exchanges within a gas. The method is quite involved and beyond the scope of math we intend to cover, but Fig. 11 shows the results for a study of air. At a temperature of 492 °R the most probable velocity is about 900 miles per hr. The rapid drop of the curve from this value shows that there are fewer molecules with lower and higher speeds and just a trace of molecules with zero speeds or very high speeds (three or more times the most probable).

As the gas temperature rises progressively to 984 °R and 1476 °R the most probable speed also increases in proportion to the square root of the rise in temperature. Doubling the temperature increases the most probable speed by 41.4%; tripling the temperature raises the most probable speed by 73.1%. The proportion of molecules at the most probable speed also decreases with rising temperature; but the proportion of molecules at lower speeds drops while the proportion at higher speeds increases with rising temperature.

Keep this picture in mind when we discuss reversibility later in the series. While most experts in thermodynamics say we don't need to know the kinetic theory, this physical picture will help to interpret many relations that classical thermo deals with only by equations.

Next part will cover more energy equations of gases—in a forthcoming issue.

AIR CONDITIONING

Continued from page 119

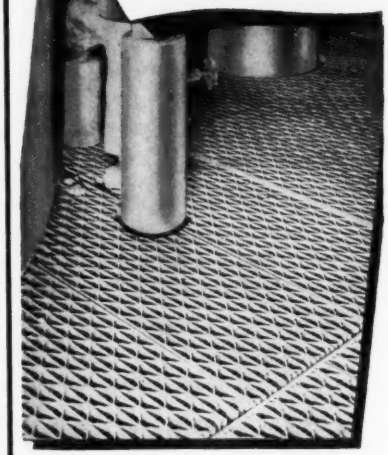
duct. But, if hot-duct size is same as the cold ducts were designed for equal required *after* all the attenuator-diffuser unit valves are moved to open the hot duct. If hot duct is smaller than the cold, find out whether the hot and cold duct, measure the actual pressure pressures and whether control points in these two ducts are based on equal static pressures.

Now move the attenuator-diffuser unit valves to the hot position. At this point it pays to check the unit's capacity. We've found cases where (1) hot ducts weren't connected to the boxes (2) foreign material could fall into the duct runout, limiting air quantity handled by the unit.

Air flow through the hot duct will be the same as through the cold duct only if static pressure at the unit inlet is same for both ducts. But branch runouts to the units are sometimes different for each inlet and the capacities will differ by a small amount.

Pressure balance. In attenuator-dif-

BOILER ROOM FLOORS MUST STAY SAFE, CLEAN



Ashes, coal and other substances under foot often make solid floors in boiler rooms unsafe.

Such hazardous materials cannot accumulate on a floor made of Irving open steel grating. Debris falls right through, making floors always clean. Dangerous fumes can escape through open grating. Floors made of Irving Grating are clean, safe at all times . . . no ankle turning, tripping, slipping, hot foots. It is fireproof, self-ventilating.

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Valuable guide to efficiency and economy in your boiler settings

This booklet on the famous Norton *engineered and prescribed* refractories can help you solve a good many problems affecting boiler operations.

In its 32 easy-to-read pages you'll find plenty of money-saving facts, plus interesting charts, diagrams and photographs describing the many uses and advantages of Norton CRYSTOLON* refractories for heat and power applications.

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For example, this booklet gives you full information on the best protection for water tubes . . . on the construction of air-cooled and solid walls . . . on laying bricks and making general repairs . . . on the correct refractories to use for every type of boiler. In addition, the different properties of various refractories are listed, and there are handy quick-figuring charts for temperature conversion, boiler efficiency, etc.

Remember — one of the most important benefits of these refractories is that Norton *engineers and prescribes* them to help you save time and money on your own particular heat and power requirements. Find out how. Just send for this booklet and your copy will be mailed immediately. Address NORTON COMPANY, Refractories Division, 441 New Bond Street, Worcester 6, Mass. *In Canada:* A. P. Green Fire Brick Co., Ltd., Toronto 5, Ontario.

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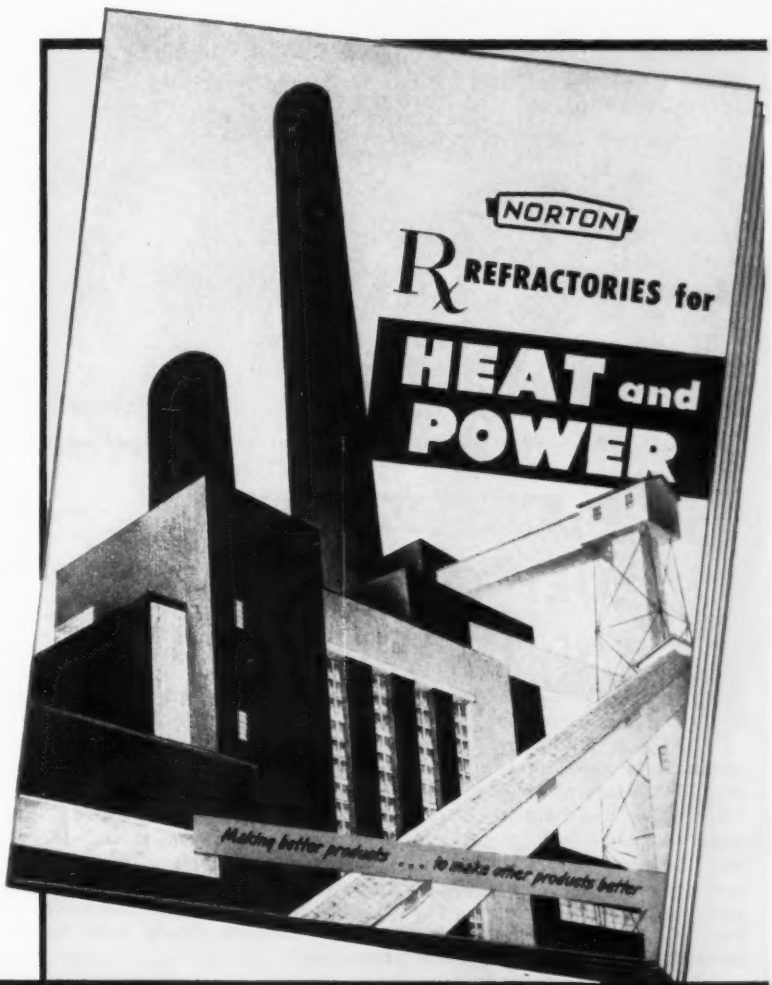

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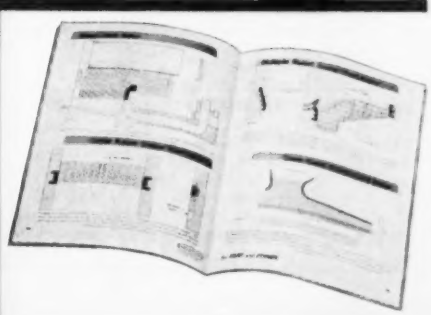
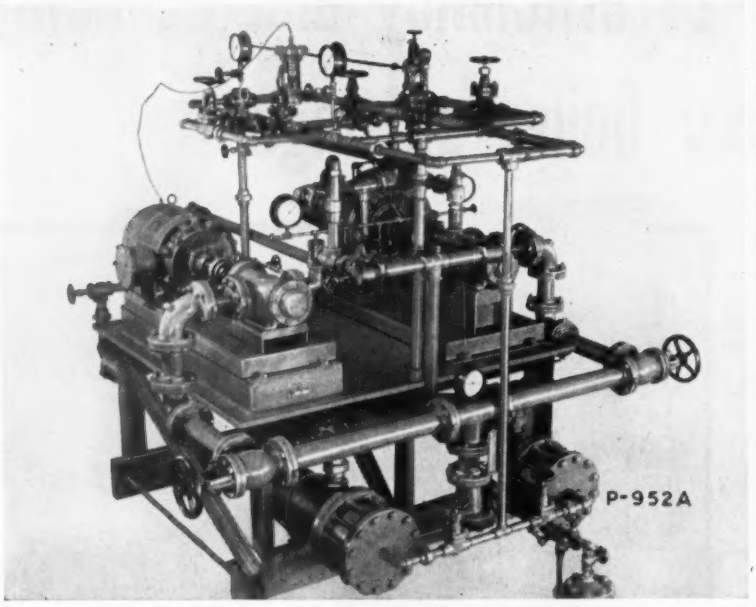


COMPLETE RANGE OF SIZES AND MODELS IN BOTH MEDIUM AND HIGH PRESSURE TYPES

MORE COMPACT THAN EVER..



P-952A Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

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AIR CONDITIONING

Continued from page 212

fuser units, pressure balance refers to setting the air capacity by adjusting the pressure-reducing valve to its design capacity. You measure pressure drop across a fixed air path within the box (or diffuser in the case of straight-line units). For any pressure drop across the unit there's a corresponding air capacity. Fig. 1, p 119, is a capacity calibration curve that relates pressure drop to air capacity for different size diffusers. The graph lists *unit static pressure* so that you won't confuse it with *minimum duct static pressure*. Curves shown, for a straightline or under-the-window unit, are to be used with the unit's inner assembly in the hinged out position.

Photo, p 118, shows the balancing operation on an under-the-window unit. Connect draft gage to the unit's static-pressure tap and adjust the valve with a slotted screwdriver fitting that's accessible through the jet plate of the under-the-window diffuser.

On ceiling-diffuser boxes you can generally reach the static-pressure top through the diffuser, via rubber tubing. Fig. 2, p 119. Valve adjustment is at center of the diffuser.

On both the octopus and end-of-box type units, Fig. 3, p 119, you'll have to work with two unit static-pressure connections to accurately measure differential pressure. Second tap eliminates effect of extension-duct resistance, an item that varies with each installation.

In an upcoming issue we'll talk about some operating snags we've found in recent installations.

More ARGUMENTS

Begins on page 142

pressure at these temperatures would have to be considered separately. Don't overlook this possibility.

If boiler is insured, Smitt can call in his inspector to determine the condition. Part of the premium cost covers this service, and he should avail himself of it immediately.

R A Foltz, *Dallas, Texas*

There was more water than Smitt thought

I do not know at what pressure Smitt operates his boiler, but apparently he had more water than he thought. I feel that part of the cherry red color came from red hot deposits on the firebox side of tube sheets.

After close inspection of the boiler I

ANNOUNCING...

a major advance in expansion joint design

New Zallea Self Equalizing Expansion Joints offer four important advantages. Years of continuous research have resulted in a new Self Equalizing Expansion Joint that lasts longer, is substantially shorter, one-third lighter, and has greater stability.

Longer life. Hundreds of cycling tests to destruction prove that you can expect as much as 100% longer life from the new Zallea Self Equalizing Expansion Joint.

Lighter weight. Weight of the expansion joint has been reduced as much as one-third. Handling and installation are easier.

Shorter length. Over-all length has been reduced as much as 30%.

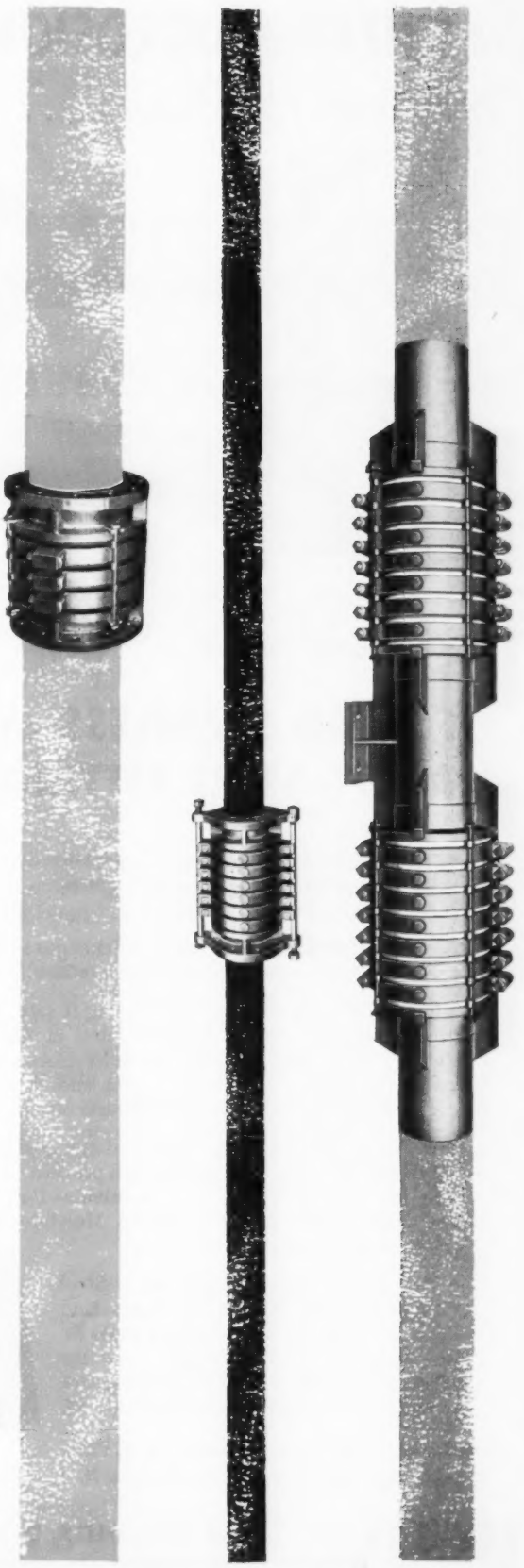
Greater stability. Reduction in ratio of length to diameter means higher stability at high test pressures—no need to support the expansion joint to prevent buckling during test.

Sizes and traverses. Sizes range from 3″ diameter to 72″ diameter, for traverses up to 7½″ in a single unit or 15″ in a double unit.

Working pressures. Although normally intended for 150 and 300 psig working pressures, Self Equalizing Expansion Joints can be designed for higher pressures.

Service. The Self Equalizing Expansion Joint is ideal for applications in long lines when there is considerable axial expansion and infrequent movement . . . such as district heating lines which seldom cool down during the heating season.

Get the complete story of the new Zallea Self Equalizing Expansion Joint in our newly published 72-page Zallea Expansion Joint Manual. Write today, on your Company letterhead, for your copy of Catalog 56. Zallea Brothers, 814 Locust Street, Wilmington 99, Delaware.



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FORGED STAINLESS or ALLOY STEEL FITTINGS

IN CORROSIVE SERVICE your pipe joints take a beating—fluid velocity and turbulence accelerate corrosion wherever there is a change in direction of flow.

AT HIGH TEMPERATURES structural changes in the metal can cause loss of strength and subsequent failure.

Those are good reasons for "playing it safe" in high pressure service with W-S Forged Stainless or Alloy Steel Pipe Fittings. W-S Stainless Fittings resist corrosion in a wide variety of process liquids and gases and high temperature steam. Available in Types 304, 316 and 304 L.

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W-S Forged Stainless and Alloy Steel Fittings can be obtained in Screw-End Type for 2,000 lb., 3,000 lb., and 6,000 lb. WOG service; Socket-Welding Type for Schedules 40, 80, 160 and Double-Extra Heavy Pipe. Send today for bulletin S-1-55.

Write to W-S Fittings Division, H. K. Porter Company, Inc., P.O. Box 95, Roselle, N. J.

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More ARGUMENTS

Continued from page 214

would have rolled the tubes as he did to make the unit tight. Having found no bad blisters on sheets or tubes, I would have tested the boiler at a hydrostatic pressure 1.5 times its operating steam pressure. If I had no leaks and no distortion during test, I would have been satisfied with metal's condition, and would not hesitate to put unit back on the line.

If Smitt carries insurance on the boiler, he should inform boiler inspector of the condition and what action he took. Inspector has a right to know. In addition, he can be very helpful.

CHARLES GILL, *Richmond, Va.*

Low water hasn't helped the boiler

The low-water condition in Smitt's locomotive-type boiler hasn't done it any good, to be sure. If it's a low-pressure unit, there is no reason for borrowing trouble. Go ahead and fire it.

But a high-pressure boiler is a horse of another color. Don't ask Joe about it. Get an inspector in, explain the whole thing; let him decide what to do.

Float-operated and other types of low-water cutoffs will fail; it happens all the time.

WALTER OTTO, *Forest Hills, N.Y.*

REPORTS from the FIELD

Begins on page 154

Niagara-Mohawk. This contract was also approved 3 to 2.

Authority Chairman, Robert Moses, speaking for the majority, said he was "firmly convinced the greatest service that could be rendered in the St. Lawrence area was in serving industry."

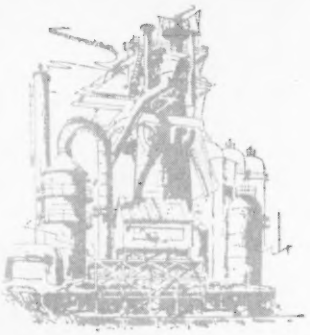
Mr Moses pointed out that Reynolds intends to spend $88,000,000 on a plant. Unlike Alcoa, Reynolds is not now located in the area.

Chairman Moses stressed that the authority has sold $335,000,000 worth of bonds for the power project without government credit behind them. Therefore, he felt that it was the trustee's duty "to get customers we promised as quickly as possible."

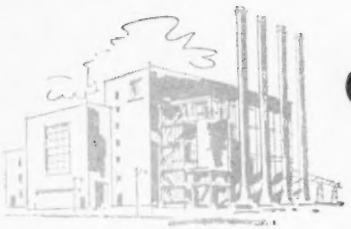
"Reynolds was the best thing that came up and we took it," he said. "Tell them to come back in six months and they'd be located before then in Ohio."

Action on a further proposal for establishment of a power pool in the area is due Feb. 4. Observers expect a fight on this one too.

(*More Reports on page* 218)

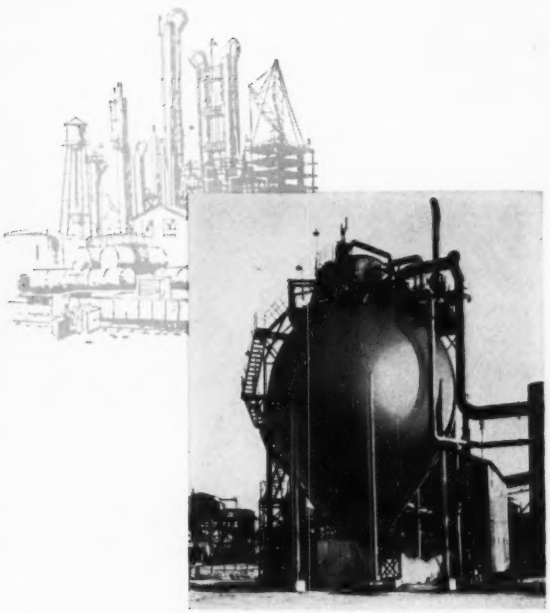


First in water conditioning



Cochrane HOT PROCESS

AT U.S. STEEL'S CLAIRTON PLANT



Designed to soften and deaerate 100,000 GPH of boiler feed water, this Cochrane unit at U.S. Steel's plant is a sludge blanket design deaerating type Hot Process Softener with a 38' dia. spherical top sedimentation tank. The Softener is followed by six 11' dia. anthracite filters equipped with surface washers.

Cochrane pioneered the versatile Hot Process Softener. Its flexibility and efficiency are unquestioned and it provides a water softening process that can handle both turbid surface supplies and clear well waters.

Cochrane Hot Process Softeners can be used to reduce silica economically and effectively. It is also possible to provide integral deaeration elements for condensate and treated makeup where required.

For medium and high pressure boilers, Hot Process can be followed by Hot Zeolite to provide zero hardness and lower solids as well as to reduce CO_2 in the steam.

If you now have a Hot Process Softener, Cochrane Hot Zeolite may be readily added, assuring higher effluent quality at lower treating cost.

Cochrane, first in water conditioning for over half a century, continues to lead the way in Hot Process and Hot Zeolite. Call our engineers for the answer to your problem. Ask for Publication 4801.

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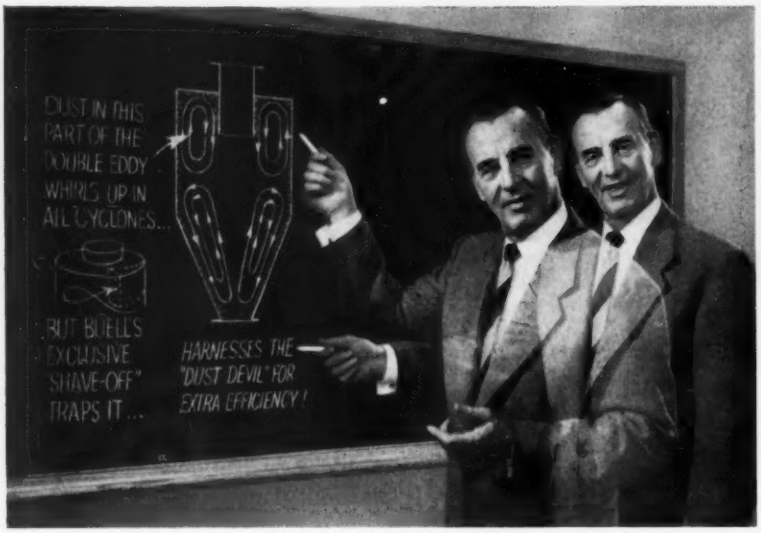
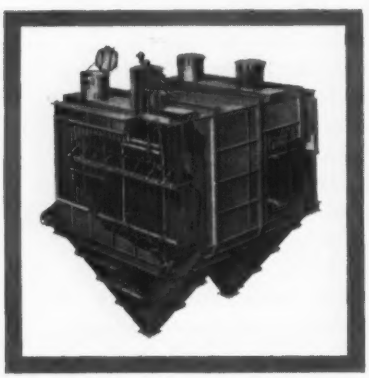
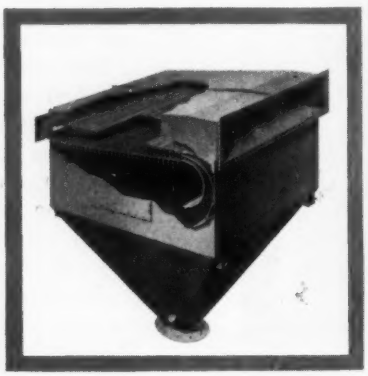

DUST IN THIS PART OF THE DOUBLE EDDY WHIRLS UP IN ALL CYCLONES...
BUT BUELL'S EXCLUSIVE SHAVE-OFF" TRAPS IT...
HARNESSES THE "DUST DEVIL" FOR EXTRA EFFICIENCY!

Other design features which increase efficiency include large, clog-proof diameter, proper proportioning for maximum dust separation, extra-heavy-gauge, wear-resistant construction . . . features which shave dust collection costs to the minimum!



Buell SF Electric Precipitator also delivers *extra dust collection efficiency*, due to unique Spiralectrodes and Continuous Cycle Rapping.



Buell Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for either natural or mechanical draft installations.

For more specific data about Buell's *extra efficiency*, write Dept. B-50, Buell Engineering Company, 70 Pine St., New York 5, N. Y.

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Experts at delivering Extra Efficiency in
DUST COLLECTION SYSTEMS

REPORTS from the FIELD

Begins on page 154

Inexpensive electric power from atom nearer reality

► LOW-COST ELECTRIC POWER from atomic energy loomed closer to reality with disclosure that organic chemicals may be the means to low-pressure cooling and moderating systems in nuclear reactors, permitting simpler and cheaper installations.

Malcolm McEwen of Dayton, Ohio, a research scientist for Monsanto Chemical Co, told a meeting of the American Institute of Chemical Engineers that preliminary engineering studies fully justify construction of experimental organic cooled reactors.

The first such reactor is now being built for the AEC by Atomics International, a division of North American Aviation, Inc, at the National Reactor Testing Station, Arco, Idaho, for completion early in 1957.

Calendar of Events

Feb 4-8—American Society for Testing Materials, annual Committee Week and Spring meeting. Benjamin Franklin Hotel, Philadelphia. Details from ASTM, 1916 Race St, Philadelphia 3, Pa.

Feb 8-9—Symposium on the Composition of Petroleum Oils—Determination and Evaluation, sponsored by Research Division IV on Hydrocarbon Analysis of American Society for Testing Materials Committee D-2 and the American Petroleum Institute Committee on Petroleum Products. Jung Hotel, New Orleans, La. Details from ASTM, 1916 Race St, Philadelphia 3, Pa.

Feb 25-Mar 1—American Society of Heating and Air Conditioning Engineers, 13th International Heating and Air Conditioning Exposition. International Amphitheatre, Chicago. Details from International Exposition Co, 480 Lexington Ave, New York 17, N.Y.

March 11-15—1957 Nuclear Congress, International Atomic Exposition. Convention Hall, Philadelphia. Details from exposition office, 304 Architect's Bldg, Philadelphia, Pa.

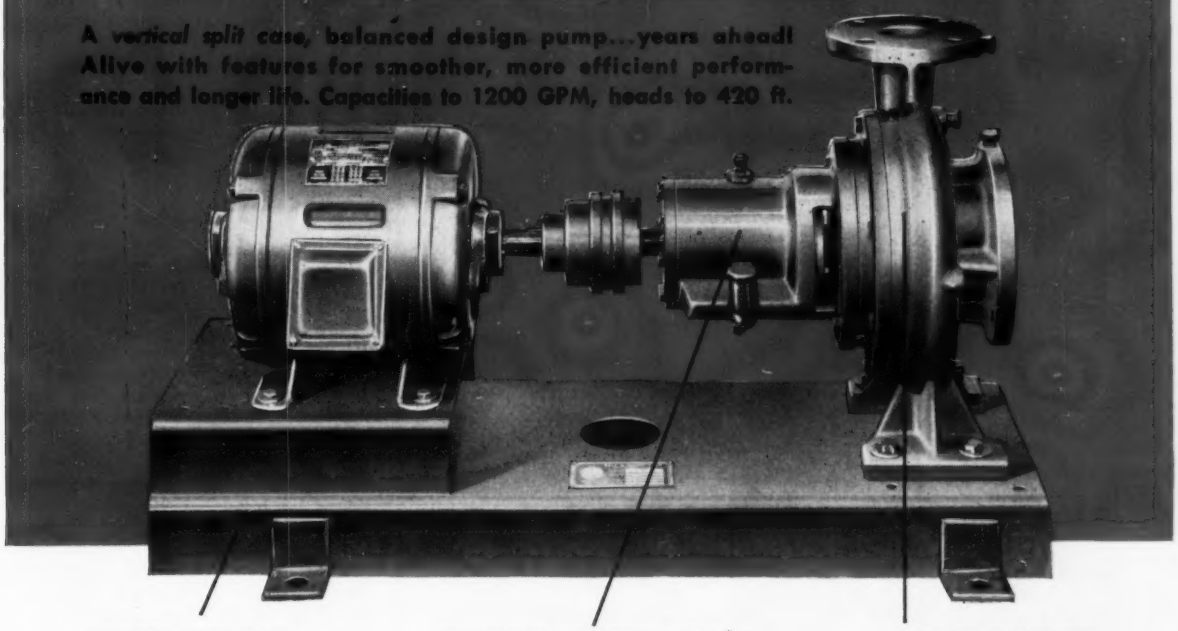
March 11-15—National Association of Corrosion Engineers, 13th Annual Conference and Exhibition. Kiel Auditorium, St. Louis, Mo. Details from NACE, 1061 M&M Bldg, Houston 2, Texas.

March 18-19—Steel Founder's Society of America, 55th Annual Meeting. Drake Hotel, Chicago, Ill. Details from SFSA, 606 Terminal Tower, Cleveland 13, Ohio.

THE *NEW* B & G SERIES 1510

TYPE B CENTRIFUGAL PUMP

A *vertical split case*, balanced design pump...years ahead! Alive with features for smoother, more efficient performance and longer life. Capacities to 1200 GPM, heads to 420 ft.



RUGGED STEEL BASE

Equipped with a heavy, welded, rolled steel base, made in four different sizes to accommodate the full range of NEMA motor frames. Base mounted construction provides a sturdy platform for proper pump and motor alignment—aids in opposing piping strains applying against the pump and motor.

REMOVABLE BEARING FRAME

Truly a major advance in centrifugal pump design! The complete bearing frame assembly, with mechanical seal and impeller can be removed without disturbing piping or motor leads. Bearing frames, less the impeller, are interchangeable in all sizes of B&G Series 1510 Type B Pumps.

SOLID TYPE VOLUTE

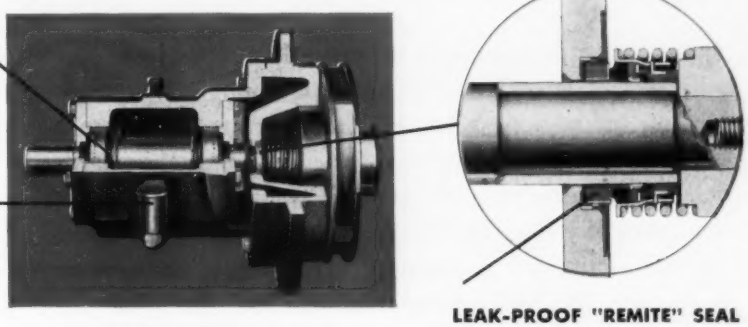
This solid based volute can be left in the pipe line when servicing the pump —offering all the advantages of horizontal split case design. Heavy cast iron construction absorbs piping strains. Openings are provided for venting and draining.

ANTI-FRICTION ROLLER BEARINGS

The B&G Series 1510-Type B Pump is equipped with Timken roller bearings to handle thrust and radial loads. This great *plus* feature assures smoother, more efficient operation.

OIL LUBRICATION

No messy, undependable grease cups —circulating oil lubrication provides positive protection to bearings. Oil level indicator permits visual check.

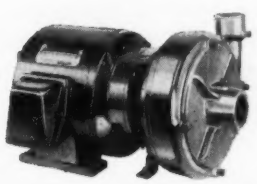


LEAK-PROOF "REMITE" SEAL

This exclusive feature eliminates the leakage which occurs with a packing gland. A carbon seal ring faces on a "Remite" floating seat—*a new material so hard it will scratch glass.* This mechanical seal is self-lubricating. A synthetic rubber bellows seals the shaft. Metal parts are steel, bronze, or stainless steel, depending upon type of service.

DYNAMICALLY BALANCED IMPELLER

Balancing chambers and pressure relief holes in the impeller reduce thrust to a minimum, lengthening pump life.

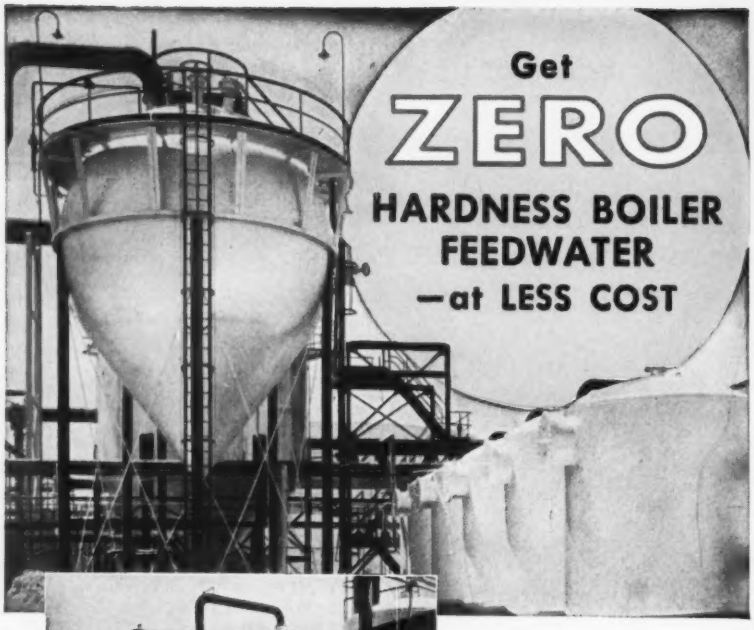


SERIES 1531 CENTRIFUGAL PUMP

Featuring vertical split case design...self-lubricating, leak-proof mechanical seal, latest NEMA motors. Super-finished shaft, oversized for minimum deflection. Impeller has balancing ring and relief holes to reduce thrust. Capacities to 1200 GPM, heads to 420 ft. Many sizes in stock.

BELL & GOSSETT
COMPANY
Dept. ER-36, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto, Canada



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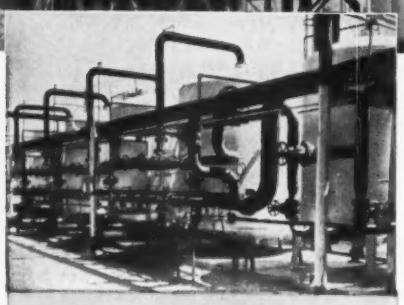
ZERO
HARDNESS BOILER FEEDWATER
—at LESS COST



Top photo shows new outdoor hot lime-zeolite softener installation in a Southern refinery. Five Nalcite HCR ion exchange units (lower photo) have output of 470,000 gallons of zero hardness water between regenerations.

with
Nalcite® (DOWEX*) HCR
HOT LIME ZEOLITE TREATMENT

Start with the simplicity of operation . . . add the low operating costs of hot lime-zeolite softening . . . all made possible by the outstanding high-temperature performance of Nalcite HCR in the zeolite softeners. Results: Zero hardness water, from virtually any raw water source, with a minimum of testing and control required. See your water treating equipment manufacturer for details on new or conversion hot lime-zeolite treatment for your plant . . . and for top softener efficiency, specify Nalcite HCR.

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In Canada: Alchem Limited, Burlington, Ontario

Nalco® PRODUCTS

When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.

REPORTS from the FIELD

Begins on page 154

March 18-21—American Society of Mechanical Engineers, Gas Turbine Power Conference. Sheraton-Cadillac Hotel, Detroit, Mich. Details from ASME, 29 W 39th St, New York 18, N.Y.

March 23-28—American Society of Tool Engineers, Silver Anniversary Technical Meeting and Convention. Shamrock Hilton Hotel, Houston, Texas. Details from ASTE, 10700 Puritan Ave, Detroit 38, Mich.

March 25-29—American Society for Metals, 10th Western Metal Congress and Exposition. Pan-Pacific Auditorium, Los Angeles, Calif. Details from ASM, 7303 Euclid Ave, Cleveland, Ohio.

March 27-28—American Society of Mechanical Engineers, Engineering Management Conference. William Penn Hotel, Pittsburgh, Pa. Details from ASME, 29 West 39th St, New York 18, N.Y.

March 27-29—19th annual American Power Conference, sponsored by Illinois Institute of Technology. Hotel Sherman, Chicago. Details from E R Whitehead, Secretary, American Power Conference, Illinois Institute of Technology, 3300 Federal St, Chicago 16, Ill.

Mar 27-29—Colloquim on Radiation Effects on Materials, co-sponsored by Office of Naval Research and Martin Co. Johns Hopkins University, Baltimore, Md.

UET center to be located in mid-Manhattan

► United Engineering Trustees, Inc, the joint corporate agency of the four major national engineering societies, has signed a contract for preliminary architectural plans and studies for a new engineering center in mid-Manhattan, N.Y.C. This is the first definite step toward construction of what is expected to make New York the "engineering capital of the world."

Announcement of granting of contract came with the announcement of

Attention: manufacturers' agents serving the power field

Questionnaires for the 1957 edition of Power's valuable *Directory of Manufacturers' Agents Serving the Power Field* are in the mail. If you have received one, please fill it out and return it promptly. If you have not received one and think you should be listed, write, wire or phone, and we will rush you a questionnaire.

6 ADVANTAGES OF A. P. GREEN PLASTIC AND CASTABLE REFRACTORIES IN WATERTUBE BOILERS

MONOLITHIC CONSTRUCTION

A monolithic refractory lining, properly installed, gives better combustion efficiency and longer, more trouble-free service than any other type lining.

ANCHORED FURNACE LININGS

A. P. Green "floating" anchors hold the refractory lining securely against the casing and permit free expansion and contraction movement.

AIR-COOLED—SECTIONALLY SUPPORTED WALLS

A. P. Green offers a simple design for air-cooled walls—no special tile are required. Provision for recovery of preheated air can be made. Alloy supporting plates are available for use in extremely high walls, over stoker arches, and burner openings, permitting replacement of any section without disturbing the adjacent areas.

LESS HEAT LOSS THROUGH WALLS

The low thermal conductivity of A. P. Green plastic and refractory castables means less heat loss through the walls, greater efficiency, and more protection for the outer casing of the boiler.

LOWER INSTALLATION COSTS

Special shapes are eliminated . . . expensive, time-consuming brick cutting is not necessary. With proper supervision, the installation can be done by average labor.

EXPERIENCED DISTRIBUTORS—QUALITY WORKMANSHIP

An authorized A. P. Green distributor, trained in refractory problems, is close to your job to give you the kind of quality workmanship your refractory job demands. He is backed by the engineering staff of the A. P. Green Fire Brick Company.

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Turner **BOILER TUBE SCALE THICKNESS INDICATOR**

STOP UNEXPECTED BOILER TUBE FAILURES

This completely new and improved model TURNER SCALE THICKNESS INDICATOR not only reads scale directly in thousandths of an inch, it is invaluable in locating pitted and eroded tubes prior to their failure, thus eliminating costly shutdowns. Write for technical data and information today.

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The Greater the Pressure... the Tighter It Holds!

There's still nothing simpler or more efficient in power line service than this Wilcox Self-Sealing Gasket which has served industry so well over the years. The U-shaped metal outer cover is packed with a resilient filling (usually rubber or asbestos). Pressure exerted on this elastic filling forces it into the cover, putting force against the adjacent flange surfaces. Thus, internal pressure that tends to blow ordinary gaskets makes the Wilcox Gasket tighter in the joint. Available with covers of copper, lead, tin, aluminum, monel, stainless steel, etc. in all sizes—standard or special.

Write for details and quotations

CHICAGO-WILCOX MFG. CO.
7707 So. Avalon Ave.
Chicago 19, Ill.

REPORTS from the FIELD

Begins on page 154

re-election of Walter J Barrett, of Glen Ridge, N. J., as president of UET. It was also the first formal revelation that all four member societies of UET, and a fifth which is expected to become a member, had voted to remain in New York. Several other cities had striven to obtain the Center.

Architects named are Shreve, Lamb and Harmon Assoc, 11 E 44th St, N. Y., designers of the Empire State building and, more recently, the new Brooklyn Supreme Court building. The announcement did not give any details as to specific location, cost, or time of completion.

New reproduction process for large drawings

► MICRO-MASTER, the first system designed exclusively for reproducing engineering and architectural drawings up to 36 x 54 inches—or even longer, uses 105mm film negatives. It yields full-sized second originals of such high quality that original tracings may be destroyed. Archival quality negatives are large enough for easy identification yet fit standard file drawers. Storage space can be reduced to 1/25 of original space. Process can restore most worn or soiled tracings. Developing and printing are precisely controlled. Also included in the system are projectors and viewers. Equipment is not for sale but service is available in the U.S. and Canada from Micro-Master, Inc, Kansas City, Mo, in association with Keuffel & Esser Company, Hoboken, New Jersey.

Business spending for plants and equipment to increase

► BUSINESS SPENDING for new plants and equipment is expected to increase again in 1957 and to stay on a high level into 1958, according to an annual survey by the McGraw-Hill Publishing Co.

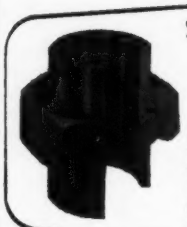
According to the report capital expenditures next year will be over $40 billion, an increase of 11% above this year's level. This year's business spending is expected to hit over $36 billion, an increase of 21% over 1955. The survey covered companies employing almost 10 million workers.

Report also showed that about two-thirds of the companies surveyed planned to maintain or increase their 1958 spending as compared with their 1957 level. Only 30% anticipated a decline in 1958.

Catawissa **PERFECT SEAL** *Unions*

HOT FORGED from solid, rectangular steel bars, designed and produced for dependable, long-life service under the severest piping conditions!

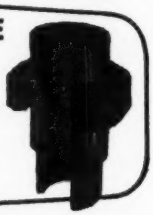
A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!



Standard & Double Extra Heavy UNIONS
Available with screwed or socket weld ends. 3000-lb. sizes ⅛" to 3"; 6000-lb. sizes ⅛" to 2".

ORIFICE UNIONS
With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

MALE & FEMALE UNIONS
With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.



FULL STAINLESS & FULL ALLOY STEEL UNIONS
With screwed or socket weld ends. 3000-lb. and 8000-lb. service.

WRITE FOR CATALOG 56
showing the complete Catawissa line of Perfect Seal products

CATAWISSA VALVE & FITTINGS COMPANY
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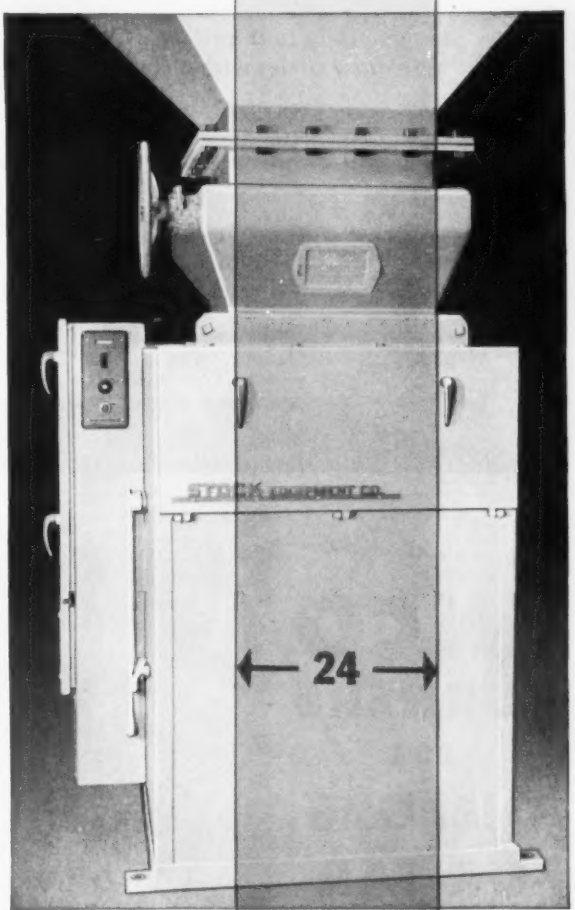
NEW S·E·CO. COAL SCALE DESIGNED SPECIFICALLY FOR LARGE CENTRAL STATIONS

Model 50 carries 24" wide stream of coal straight through without baffles, sloping skirts, or other restrictions

Modern push-button power plants burning large quantities of coal find it more desirable than ever to obtain accurate, up-to-the-minute coal weights. These weights help operators get the last BTU from each pound of coal by helping them determine boiler efficiency, keep inventory records and balance mills.

To provide these weights continually and without undue maintenance requirements, Stock Equipment Company engineers have developed the Model 50 Coal Scale. The inlet of this scale is a full 24" inside square. The extra wide feeder belt carries a stream 24" wide. The stainless steel weigh hopper has a 24" wide outlet. Because there are no restrictions or baffles inside the scale body, coal passes through easily, dependably, giving you the maximum in accuracy and trouble-free performance.

The Model 50 Coal Scale is only one of the ways in which Stock Equipment Company continues to meet the growing and changing needs of modern power plants. Years of experience in bunker to pulverizer and stoker equipment, combined with a constant attention to detail, make any S-E-Co. equipment the best you can buy for the job.



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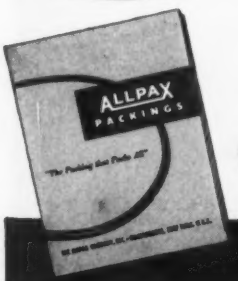
BUNKER TO PULVERIZER AND
BUNKER TO STOKER EQUIPMENT

STOCK Equipment Company

745-P HANNA BLDG., CLEVELAND 15, OHIO

—as easily and quickly as you can draw circles with a compass.

The Allpax gasket cutter uses our patented "ironing" principle that presses the material flat to prevent buckling and tearing while cutting. It cuts circles from ¼" to 36" in diameter to a tolerance of 1/64". Why risk costly delays in operation when you can replace a gasket in a jiffy with this handy tool.



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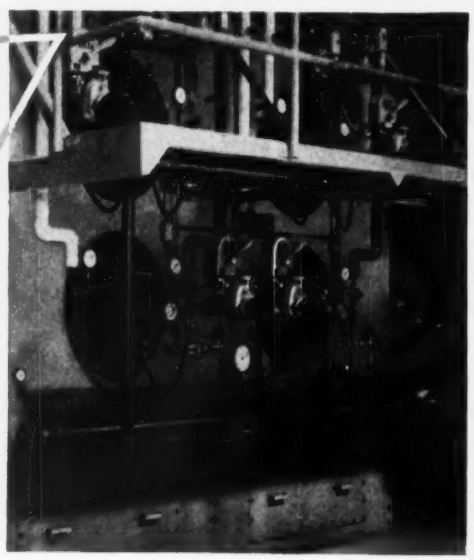
160 Jefferson Ave. • Mamaroneck, N. Y.

ENCO BURNERS FOR OIL, GAS OR TAR

Steam Or Mechanical Atomizing 1 TO 1000 GALLONS PER HOUR



Designed for operation with either gas, oil or both with natural or forced draft. They can be depended on for maximum combustion efficiency.

ENCO Interchangeable Oil-Burners can be changed instantly to operate by either steam or mechanical pressure atomizing over a wide capacity range.

ENCO Oil Atomizers are applied to various types of standard pulverized-coal and gas-burner units cold starting or for full load operation when coal or gas is not available, or when oil is the more economical fuel.

Send for Bulletin OB-53 describing ENCO Gas and Oil Burners, also complete Pumping and Heating Units.

EC 811

THE ENGINEER COMPANY, 75 West Street, New York 6, N. Y.

More TECHNICAL BRIEFS

Begins on page 156

Although the factors favorable to the outdoor station result in a lower cost station electrical plant, it must be recognized that the greatest portion of the reduced overall cost in an outdoor station of the Pittsburg design lies in the building structure and the high-pressure piping. Note that with an overall cost of $106 per kw of plant capacity for this station, and with the cost for accessory electrical equipment including motors of $9 per kw, both of these cost figures are less than the same cost figures for recent indoor plants. *AIEE paper No. 56-768.*

Eastlake reappraised. *By C F Paulus, The Cleveland Electric Illuminating Company.*

Twenty-five years passed between the design of Eastlake, this system's newest plant, and the last power plant designed for a new site. During this period they met load requirements by adding units at existing plants or by duplicating plant designs. In this 25-yr period there were many advances in the technology of steam turbine generator plants. New equipment became available and electrical apparatus was made more reliable. The manufacturers were able to build larger and larger machines. Some of these improvements were applicable to units added to existing power plants; some were not.

This paper describes very briefly some of the features of the first three units at the Eastlake Plant of the Cleveland Electric Illuminating Co from the electrical viewpoint. It enumerates a number of practices which were new to the system or to the industry. It then takes those practices which are being modified for new units now being engineered and discusses them in greater detail. *AIEE paper No 56-776.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

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You Get Them in MIDWEST PIPING

In the fabrication and erection of every high pressure and/or high temperature piping installation, there are intangibles important to the success of the job . . . things that cannot be spelled out in the specifications but are essential to getting superior piping at an economical price.

Important among these is the experience of the fabricating and construction organization . . . experience on all kinds of projects so that the possibilities and limitations of all piping materials are well understood. Midwest has fabricated and erected the piping on many critical jobs . . . including numerous atomic energy projects and Kyger Creek (the largest steam power plant ever handled completely by one piping contractor).

Another is a questioning attitude . . . a frame of mind that habitually asks (before the job is placed in the shop for fabrication): "Have the pre-fabricated sub-assemblies been so planned that the field work is minimized and simplified as much as possible?" Highly skilled Midwest piping engineers carefully analyze every job with this question in mind.

For power plant or process, the customer gets the most for his money when he buys Midwest Piping.

Main steam piping at Kyger Creek Plant which has a capacity of 1,075,000 kw and is the largest power plant piping contract (combining fabrication and erection) ever performed by a single contractor.

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7670

MIDWEST PIPING FABRICATION AND CONSTRUCTION

Offer you many advantages

More FREE LITERATURE

Begins on page 169

8 **Air-cooled compressors,** both one- and two-stage units with working pressures from 85 to 175 psi, are described in 16-p bulletin AC-15. Gardner-Denver Co, Quincy, Ill.

★ **Reciprocating compressor** bulletin DS-361 contains ratings and data on 125- and 150-hp units, plus revised ratings on 60- 75- and 100-ton condensers. ★Request direct on company letterhead to The Trane Company, LaCrosse, Wis.

CONTROLS—Electric, Mechanical

9 **Automatic controls.** Illustrated 12-p bulletin 6f/MI includes data on temperature, pressure, humidity controls; flame-safeguard system; industrial motors; relays; dampers; operators; panels and cubicles. Minneapolis Honeywell Regulator Company, Wayne and Windrim Aves, Philadelphia 44, Pa.

10 **Equipment** for the measurement and control of liquids and gases is covered in 38-p catalog 005. Table of contents lists primary elements, meters, orthoflow, laminair, gages, controllers, valves, pitot equipment. Simplex Valve and Meter Company, Lancaster, Pa.

11 **Regulator.** Self-operated units, used to control pressures of water, steam, oil, gas or other fluids, are described in 4p bulletin C-655. Fisher Governor Company, Marshalltown, Iowa.

ELECTRICAL EQUIPMENT

12 **Industrial ac motor.** Illustrated 4-p bulletin B-2501 describes totally-protected unit and its components. Motor operates within a maximum temperature rise of only 40 C. Reliance Electric and Engineering Co, 1088 Ivanhoe Rd, Cleveland, Ohio.

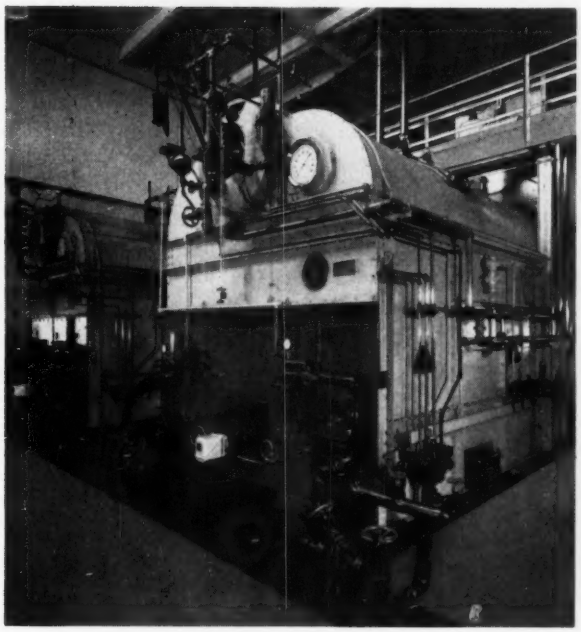
12A **Package substations** are described in 32-p bulletin GEA 5276C. Contains photos, diagrams, information on following substation arrangements: (1) simple radial with one feeder (2) simple radial with one to four feeders (3) radial with looping high-voltage circuit (4) high-voltage selective for two incoming lines. General Electric Company, Schenectady 5, N. Y.

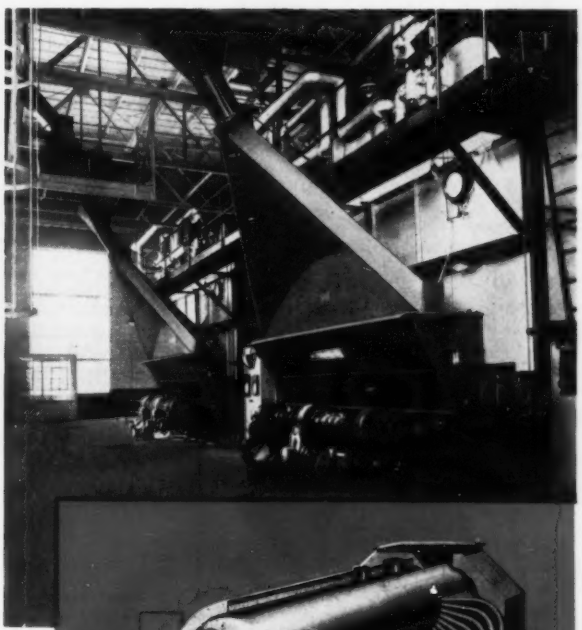
13 **Boxes and cabinets.** Illustrated 24-p catalog 10 includes data on junction and pull boxes, conduit boxes, hinged cabinets, explosion housings and fixture outlet boxes. Spring City Electrical Mfg Co, Spring City 73, Pa.

14 **Thermostats.** Illustrated 8-p bulletin details design, construction and operation of tubular type *Temp-Guard* thermostats. Applications include (1) protecting electric motors against overheating, overloading (2) turning current on and off in cycling systems (3) detecting fires, activating alarm and sprinkler systems. The Franklin Dales Co, 180 E Mill St, Akron, Ohio. *(Continued on page 228)*

KEELER "CP" ALL-PURPOSE BOILER

continues to deliver more steam capacity in a given space . . . larger combustion chamber with less head room than other types





Left above—Two oil fired Keeler "CP" boilers, each with 16,500-lb. steam capacity. Right above—Two Keeler "CP" boilers, each with 60,000-lb. steam capacity, operating with multiple retort bituminous coal stokers.

In thousands of operations throughout the nation and abroad, the Keeler "CP" continues to be the "pacesetter" in providing a reliable, efficient source of low cost steam for power, process and heat requirements—with user reports like these . . .

"fuel savings of approximately $700 per month" . . ."reduction of 25% over cost of operating previous boilers". . ."operating almost continuously at 200% to 250% of rating and maintenance has been practically nothing"!

The Keeler "CP" is a fully steel encased and insulated water tube steam generator with water cooled walls. Among its many features, the "CP" water circulation occurs in a free and unrestricted flow, without the use of internal baffle plates. This permits operation at high overloads with exceptionally dry steam and no disturbance of the water level. The "CP" is readily convertible to all methods of firing, for all types of fuels—coal, oil, natural gas or waste gas.

Keeler boiler efficiency and dependability is available in a size unit required for your service . . . write or phone for complete information.

KEELER Type CP

READILY CONVERTIBLE

Original of its type, the "CP" delivers high efficiency with induced or natural draft operation—designed for all types of fuel and readily convertible at minimum cost. Made in a wide range of sizes in pressures to 500 psi and capacities to 150,000-lbs. of steam per hour. Shipped shop assembled up to and including 350 rated horsepower.

The Seal of Quality in Water Tube Boilers

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No. M-2A: Type CPM Package Boilers
No. DK-1: Type DK Package Boilers
No. MK-1: Type MK Boilers

KEELER WATER TUBE Boilers

— ESTABLISHED 1864 —

E. KEELER CO.

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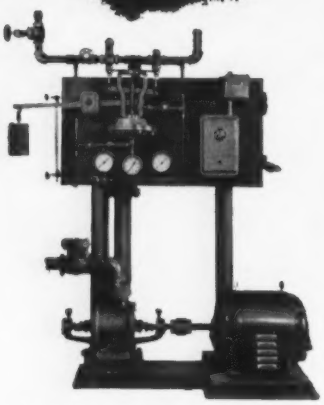
—OFFICES IN PRINCIPAL CITIES—

Cut Steam Costs

with Stickle's differential drainage and boiler return system



A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
2. Raises production with higher, more uniform boiler pressure, higher temperature steam.
3. Reduces use of raw make-up water 85% to 90%.
4. Cuts maintenance on boilers, steam lines, traps and valves.
5. Improves quality by permitting operation of processing units at peak efficiency.
6. Cuts power used for pumping up to 75%, since system requires only 25 lbs.
7. Automatically maintains positive circulation without steam loss.
8. Eliminates flash steam waste.

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SINCE 1905

Steam Traps • Feed Water Heaters
Regulating and Reducing Valves
Drainage and Boiler Return Systems

More FREE LITERATURE

Begins on page 169

15 **Oil circuit breakers** (outdoor) in ratings of 14.4 to 69 kv, 500 to 3500 mva, are described in bulletin 71B8475A. Allis-Chalmers Manufacturing Company, 952 S 70th St, Milwaukee, Wis.

16 **Armor cable.** Thirty-six page, 8x5-in. booklet 19-606 is devoted to photos showing terminations and splices; connections to switchgear, motors and plug-in bus; special installation problems; typical installations and "before" and "after" illustrations showing older wiring system side by side with new interlocked armor cable system. General Electric Company, Bridgeport 2, Conn.

17 **Wires and cables** are subject of 40-p bulletin 31-C-671. Contains data on weathering properties of *Type RR* rubber insulated-neoprene sheathed, nonmetallic cables. National Electric Products Corporation, Gateway Center, Pittsburgh 22, Pa.

METERS AND INSTRUMENTS

18 **Portable** potentiometer pyrometer is described in 8-p bulletin 9B. Unit has interchangeable direct-reading scales. Technique Associates, 211 E South St, Indianapolis 25, Ind.

19 **Panel meters,** shunts and current transformers—available from stock—are described in 6-p bulletin 2057. Simpson Electric Company, 5200 W Kinzie St, Chicago 44, Ill.

20 **Combustion analyzer.** Illustrated 4-p bulletin E65-5 describes analyzer which indicates percent by volume oxygen and combustibles present in exhaust gases from all types of boiler and industrial furnaces. Bailey Meter Company, 1050 Ivanhoe Rd, Cleveland 10, Ohio.

21 **Gas liquifier.** Photos and drawings in 6-p bulletin show operating cycle and construction of the machine. Technical details cover speed, efficiency, yield, cooling-water consumption, weight and size. Instruments division, North American Philips Company, Inc, 750 S Fulton Ave, Mount Vernon, N. Y.

22 **Thermal conductivity analyzer.** Illustrated 12p catalog 56-1008-59 explains principle, construction, operation of analyzer used for determining amount of CO_2, H_2, He, CH_4, etc. The Hays Corporation, Michigan City, Ind.

VALVES

23 **Guide** for selecting valves, boiler mountings, lubricating devices is title of revised circular 555. Completely indexed for easy reference. Lunkenheimer Co, Cincinnati 14, Ohio.

24 **Packless valves** for applications involving hazardous liquids and gases, as well as uses in nuclear energy installations, are described

MURCO Gate Hoists are designed for any size power dam and built in a wide range of capacities—from over 100 tons down to less than 1 ton . . . from the largest motor operated gate hoist to the smallest hand operated hoist . . . back of every MURCO Gate Hoist are over 70 years of designing and building gate hoists. From this experience we have accumulated designs and patterns that may fit your requirements. In planning power dam gates, we suggest you write us before your plans for the project as a whole are completed . . . it may save you expense and important preparation time.

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Hall Industrial Water Report

VOLUME 5 FEBRUARY 1957 NUMBER 1

Unscheduled Boiler Outages Are the Hobgoblins of Steam Plants

With demand chasing capacity like the famed headless horseman, unexpected loss of a boiler can really be a nightmare. Routing these nightmares by helping operators to keep steam plants trouble-free is the function of chemical engineers skilled in water technology. Hall Laboratories assists thousands of plants to keep their boilers on the line.

Package Boilers Operate Continuously

Three shifts a day, seven days a week, for over five years, with 100 percent make-up of zeolite softened water, the two-drum package-type boiler at a chemical manufacturing plant in Pittsburgh has performed without one unscheduled outage due to water.

The boiler is a 25,000 pounds per hour unit with continuous one and one-half inch floor, wall and roof tubes. Hall engineer L. C. Bishop reports that these tubes have never had to be acid cleaned nor turbined. Plant management was immensely pleased when a recent inspection showed the tubes and drums to be virtually like new.

This record is a tribute to the careful water conditioning work done by the operating men under the guidance of Hall Laboratories.

Spring Exam No Terror At This College

For some years a college in Massachusetts had treated boiler water with trisodium phosphate in a hit or miss manner. Each spring the boiler tubes were so dirty with sludge and scale that the engineer had to clean them by running a knocker turbine through the tubes and following up with a cutter turbine.

A couple of years ago the college retained Hall Laboratories to set up more satisfactory water conditions. The last time the boilers were inspected it was no longer necessary to use the knocker turbine. As a matter of fact, the cutter turbine was used only as a precautionary measure and the time spent on the job was only half that previously required.

J. A. Gregory, the Hall engineer who services the plant, points out that this job is a good example of how a Hall engineer, with the co-operation of the operating men, can clean up a bad boiler deposit problem.

Value of Water Treatment No Day Dream

G. W. Rudolf and T. A. McConomy, engineers in Hall's Washington, D. C. office, recently inspected three boilers at an Atlantic Coast shipbuilding company.

One of the boilers had been retubed and had operated with water conditions recommended by Hall since being returned to service. The second had operated about eight months without boiler water treatment and then four months with Hall recommended water conditions. A third boiler had operated for approximately eight months without treatment.

The first boiler was found to be free from scale and corrosion with just a very small amount of loose sludge in the mud drum. There was a large accumulation of loose scale in the mud drum of the second boiler, indicating that proper water conditions were resulting in removal of the scale which had been deposited when no water conditioning was practiced. The third boiler was very badly scaled and turbining was necessary to put it in shape for further operation.

With this clear-cut evidence, the plant operating men were completely convinced of the value of Hall supervision of water conditioning.

Expert Diagnosis Ends Plant's Troubles

Unhappy about the corrosion and deposits occurring in their steam plant, a Canadian rubber manufacturing company sought out Hall Laboratories to help them with their problems.

J. S. Sullivan, one of the service engineers in Hall's Toronto office, conducted a survey of the boiler and condensate systems as a first step in bringing the plant to trouble-free operation. Boiler water conditioning for scale prevention was necessary, but by measuring corrosion rates in the condensate systems Sullivan was able to show that condensate treatment was unnecessary.

After setting up a regular chemical feeding schedule and prescribing control tests and procedures, Sullivan nursed the plant along during frequent service visits, suggesting desirable changes as treatment progressed.

A recent boiler inspection report stated that the boiler was in very good condition internally. This is the second unit to receive such a favorable report since the plant started to use Hall system.

When the editors of the Encyclopedia of Chemical Technology wanted a concise discussion of "Water, Industrial" for the final volume of their series published in 1955, they asked Dr. Everett P. Partridge, Director of Hall Laboratories, to write it. Reprints have been distributed recently to Hall clients. If you would like a copy of this 21-page chapter, it is yours upon request.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Division of Hagan Chemicals & Controls, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

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17

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164 OBSERVER HIGHWAY
HOBOKEN, N. J.

More FREE LITERATURE

Begins on page 169

in 22-p bulletin F. Fulton Sylphon division, Robertshaw - Fulton Controls Company, Box 400, Knoxville 1, Tenn.

25 **Gate and needle valves.** Forged steel units, designed for the petrochemical power and process industries, are graphically described in 12-p folder DH-80. R P&C Valve division, American Chain & Cable Company, Inc, Reading, Pa.

26 **Air-release valves,** used for (1) venting air from hot-water heating systems (2) venting air from chilled water-cooling and air-conditioning systems (3) releasing air from industrial and municipal pipelines and other equipment, are described in bulletin 856. The V D Anderson Company, 1935 W 96th St, Cleveland 2, Ohio.

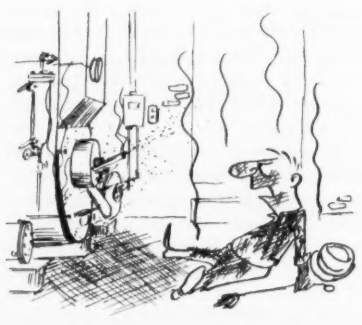
WELDING

27 **"High-speed welding** of steel compressor cases" is title of reprint ADR 100. Covers successful use of inert-gas metal arc welding to production of a hermetic line of compressors. Air Reduction Sales Co, 150 E 42nd St, New York 17, N. Y.

28 **Welding rod** comparison chart DH-1218-J details physical properties as welded; gives tensile strength, elongation, typical uses of gas welding rods, bare electrodes, automatic welding wire and metal spray wire. Page Steel and Wire division, American Chain & Cable Company, Inc, Monessen, Pa.

29 **Stud welding.** Complete 36-p bulletin contains index and reference to equipment and accessories used in stud-welding applications. Each spec lists size minimums and maximums; details mechanical properties, chemistry, thread sizes, plating and annealing info. KSM Products, Inc, Merchantville, N. J.

30 **Electrodes** and accessories are described in 28-p bulletin RW-10. Included are applications, specs and dimensions of standard welding tips, wheels, dies and holders. Ampco Metal Inc, 1745 S 38th St, Milwaukee 46, Wis.



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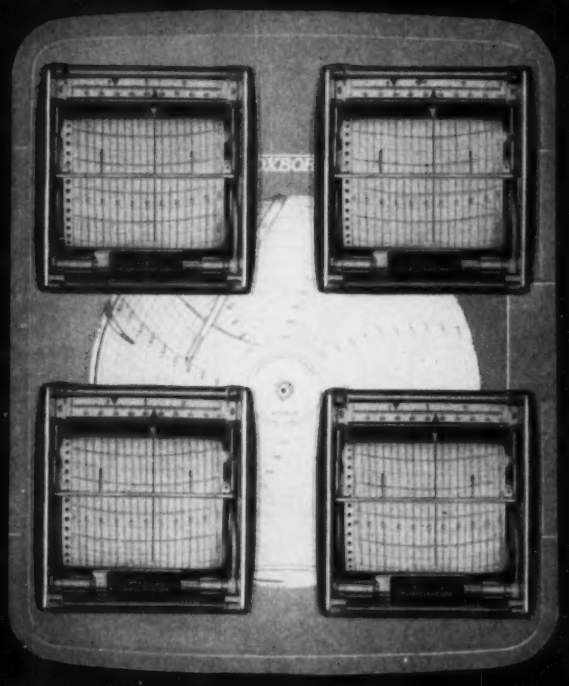

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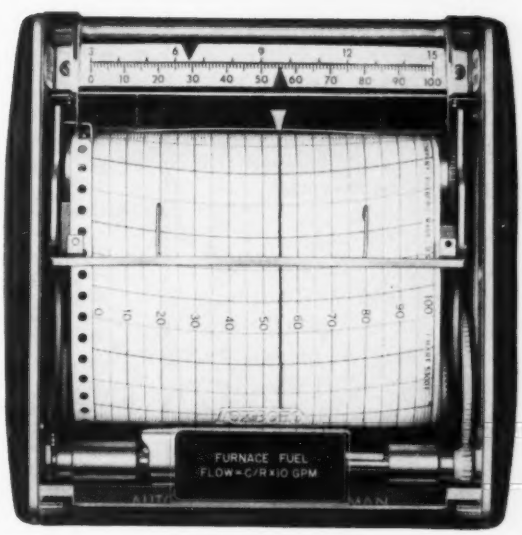

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APPOINTMENTS

Corporation executive changes

Crane Co: Frank F Elliott, chairman of the board; Neele E Stearns, president. **The Ohio Brass Co:** George L Draffan, chairman of the board and chief executive officer; Roger A Black, president and chief administrative officer. **Philadelphia Insulated Wire Co:** Joseph J Dowling, president.

Prat-Daniel Corporation: Conrad H Pinches, president; Louis C Whiton, chairman of the board. **H K Porter Company, Inc:** T M Evans, chairman; Charles L Holbert, executive vice-president. **Union Carbide Nuclear Company:** Lyman A Bliss, president.

The Wayne Pump Company: Bruce A Dean, vice-president. **Carrier Corporation:** John M Rachal, vice-president. **Brown Boveri Corp:** A Stanley Stys and John C Trackman, vice-presidents. **Johnson Service Company:** John H Colby, vice-president and general sales manager. **Combustion Engineering, Inc:** Walter S Bencher, vice-president. **Illinois Gear & Machine Company:** T S Pacer, E B Smiley, G P Sullivan, vice-presidents.

Operations executive changes

General Electric Co: C Benjamin Ramsdell, general manager of commercial and industrial air conditioning dept. **Allis-Chalmers Manufacturing Co:** G W Clothier, manager of motor and generator dept; W L Peterson, manager of regulator dept; J R Mann, manager of transformer dept. **Great Northern Oil Co:** A S Gilliam, plant manager of Pine Bend refinery. **Hewitt-Robbins, Inc:** Edward J Mytkowicz, manager of operation of Chicago plant.

Engineer changes

The Hays Corporation: Frederick M Rutledge, manager of project engineering. **General Electric Co:** Glenn B Warren, consultant, turbine division; John W Stribling, consultant, mechanical engineering in company's plant engineering and maintenance service. **Armour Research Foundation** of Illinois Institute of Technology; William F Cramer, senior engineer. **A W Cash Company:** William Schupner, chief engineer for fluid power products. **Eutectic Welding Alloys Corporation:** Charles Liechti, chief engineer, technical services. **Goulds Pumps, Inc:** Philip J Olmstead, chief engineer.

New district managers

Worthington Corporation: E Weston Hammond, Los Angeles district office; J R Matullo, Newark district office. **Thomas A Edison, Inc:** John E McDonnell, New York district manager for

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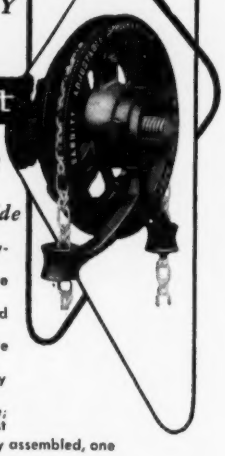

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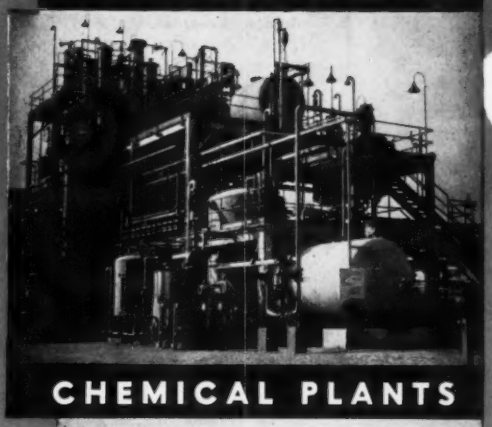
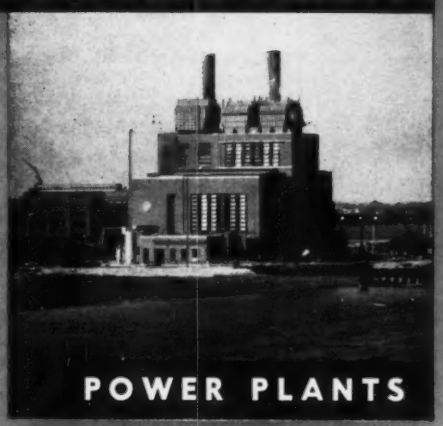


CHEMICAL PLANTS



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There are good reasons behind the trust which America's key industries have placed in Vogt valves, fittings, and flanges for half a century. They know that *drop forged materials* are uniform in structure, fine grained, and free from porosity. They know, too, and appreciate the meticulous care given these products through every stage of forging and machining in Vogt's modern shops, and about the many rigid tests and inspections. And that is why these products enjoy such an impressive record of performance in withstanding the shocks and stresses imposed by high or low pressures and temperatures and in resistance to erosive and corrosive conditions.

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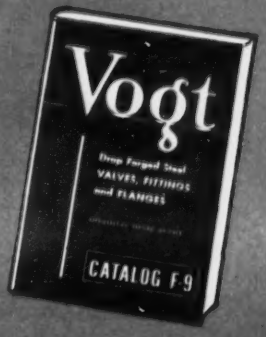

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More APPOINTMENTS

Begins on page 232

Edison Storage Battery division; Robert J Sentenac, Glendale, Calif. office, H E Van Cleef Jr, Chicago office, both in instrument division. **The Bristol Company:** John E Kearns, San Francisco office.

Rockwell Manufacturing Company: Robert B Kitzmiller, Los Angeles district, meter and valve division. **American Chain & Cable Company, Inc:** S E Havens, Pacific Coast territory, Wright hoist division. **Simplex Valve & Meter Company:** Hapgood Kipp, Philadelphia district. **Bailey Meter Company:** George D Williams, Boston office.

New district offices

Johnson Service Company: in Duluth, Minn., C W Browne, sales engineer in charge; in Moline, Ill., Charles F Hoscheid Jr, sales engineer in charge; in Harvey, Ill., Donald G Cherry, sales engineer in charge **The Philip Carey Mfg Company:** at 1510 Orenda Rd, Memphis, Tenn., W B Ott, manager; in Insurance Exchange Building, Des Moines, Iowa, E D Smith, manager. **Clark Controller Company:** at 2319 Maryland Ave., Baltimore 18, Md., Edward M Hanson, manager. **Dorr-Oliver Inc:** at 2125 Maryland Ave, Baltimore, Md., Kelsey C Lindstrom and Benjamin F Rockecharlie, sales engineers.

New distributors

For **Automatic Switch Company:** McKeever Electric Supply Company, 212 N Grant Ave, Columbus 15, Ohio. For **Hills-McCanna Company:** Neptune Supplies, Inc. 209 N Peters St, New Orleans 16, La. For **Chrysler Corporation:** Power Tractor Company, 2262 N Oxnard Blvd, Oxnard, Ventura County, Calif., handling industrial engine sales. For **Westinghouse Electric Corp,** Sturtevant division: Williams, Gritton and Wilde, Salt Lake City, Utah.

New representatives

For **Hills-McCanna Company:** Hayes Pump & Machinery Company, 100 Vine St, Somerville, Mass.; McRae Engineering, Ltd, Room 701, Concourse Bldg, Toronto 1, Canada. For **Perkin Engineering Corporation:** Loren F Green and Associates, Illinois, Wisconsin, Indiana and eastern Iowa territories. For **Simplex Valve & Meter Company:** Patterson-Townsend, 212 N Independence Blvd, Charlotte, N.C. For **Tuthill Pump Company:** The Paquin Co, 13405 St. Clair Ave, Cleveland 10, Ohio.

Recent moves

Chase Brass & Copper Co: office and warehouse to 55-60 58th St, Maspeth, L.I., N.Y. **Stearns Electric Corpora-**

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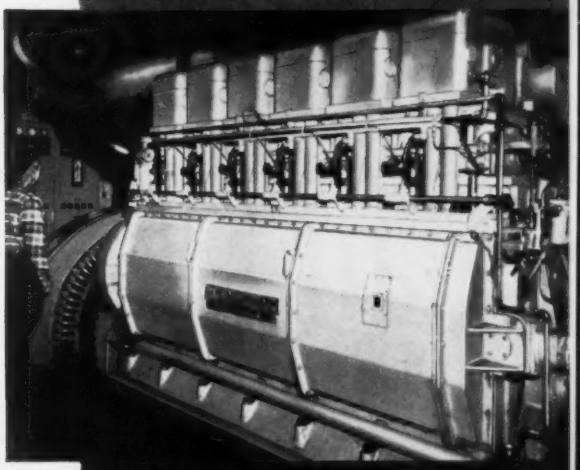
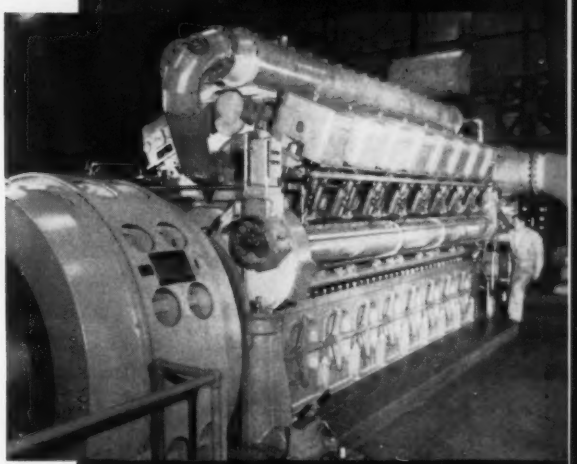
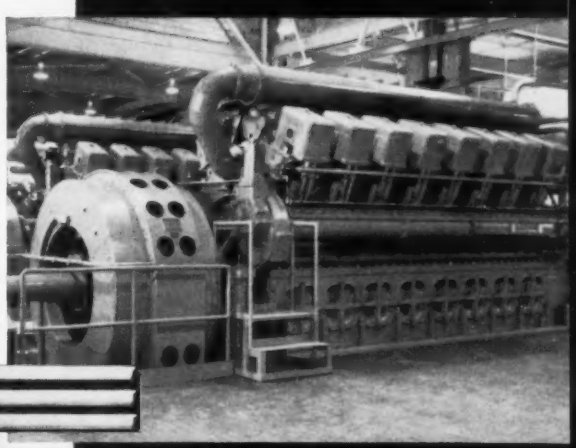


1 ***For standby service*** . . . this 1200 hp, 840 kw Nordberg *Supairthermal® Diesel* Generator is serving a Midwestern Utility Company.



2 ***For peak load service*** . . . this is one of three Nordberg *Supairthermal* Diesel generator units, ranging from 1150 kw to 2285 kw, now serving a Southern Utility Company.



3 ***For boosting voltage*** . . . these are two 3500 hp, 2500 kw Nordberg Diesel Generator units serving an Eastern Utility Company.

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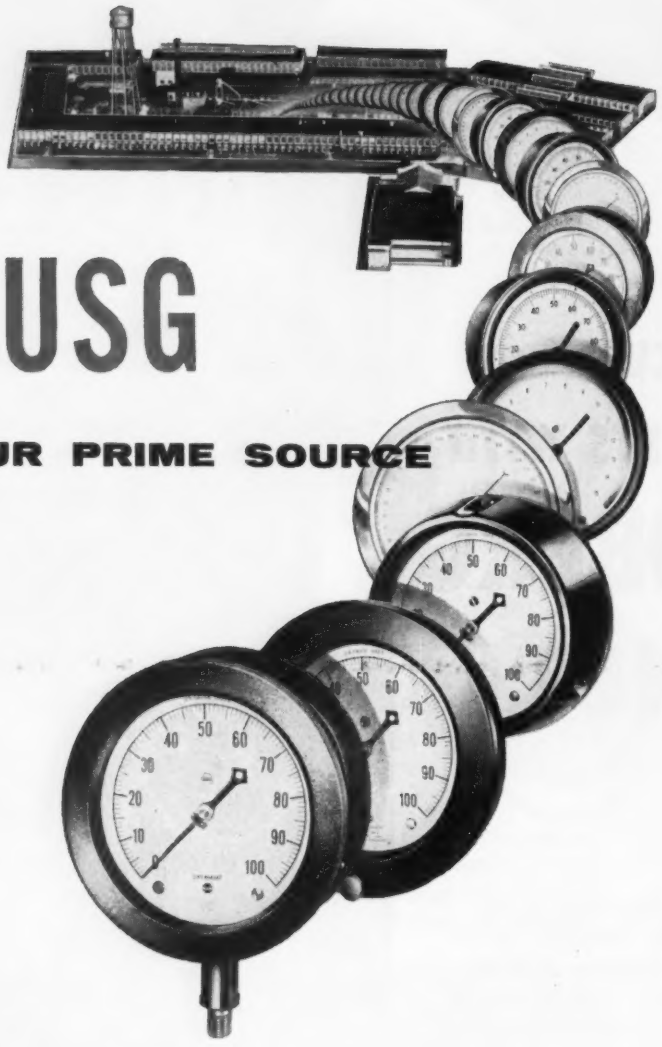

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More APPOINTMENTS

Begins on page 232

tion: to 120 N Broadway, Milwaukee 2, Wis. **United Conveyor Corporation:** to 6505 N Ridge Blvd, Chicago 26, Ill. **Johnson Service Company:** Macon, Ga. office to 803 Second St; Grand Rapids, Mich. office to 1346 Burton St, SE. **Robertshaw-Fulton Controls Company:** Fielden Instrument division to larger quarters at 6116 St. Clair Ave, Cleveland, Ohio.

Institute elections

National Industrial Leather Association: William H Chestnut, president; John R Lovett, vice-president; A B Laurence, treasurer. **National Electrical Manufacturers Association:** A A Berard, president; N J MacDonald, J J Mullen Jr, B C Neece, W V O'Brien, J L Singleton, vice-presidents. **Stanford Research Institute:** Fred B Ortman, associate director.

Obituaries

Herbert Metz, 64, retired director, district manager and member of Graybar Electric Company's executive committee, on December 4th.

Terryl B Montgomery, 56, chief engineer of Allis-Chalmers Manufacturing Company's electrical application department, on December 7th.

Henry V Erben, 58, formerly executive vice-president, more recently consultant to the president of General Electric Company, on December 26.

Fluor Corp of Canada, Ltd, Los Angeles engineering and construction firm, has been awarded a contract to engineer and construct a detergent alkylate plant for Imperial Oil Ltd, at Sarnia, Ont, Canada.

Charles W E Clarke has opened an office as engineering consultant, located Main Line Professional Building, Narberth, Pa.

Stauffer Chemical Co will build a major plant to produce titanium tetrachloride at Ashtabula, Ohio. This facility will supply the needs of the titanium sponge plant which National Distillers Corp plans for the same area.

Attention: manufacturers' agents serving the power field

Questionnaires for the 1957 edition of POWER's valuable *Directory of Manufacturers' Agents Serving the Power Field* are in the mail. If you have received one, please fill it out and return it promptly. If you have not received one and think you should be listed, write, wire or phone, and we will rush you a questionnaire.

Quick as a cat... Quiet as a mouse

CHAPMAN
Tilting Disc Check Valve

There, in a nutshell, is the story of a Chapman Tilting Disc Check Valve . . . quick as a cat, quiet as a mouse. It's designed that way. It's built that way . . . for fast, sure, quiet action. Or, in other words, it's yours for best performance at lowest long-range operating costs.

With a Chapman Tilting Disc Check Valve, there's no noise, no vibration, no fluttering. There's no banging or slamming with damage to system or valve. There's no scraping or wearing of disc and seat. Your head loss or flow resistance is kept at a minimum.

To put it briefly, with a Chapman Tilting Disc Check Valve, there's little or no maintenance even under severe operating conditions.

For Chapman Tilting Disc Check Valves in iron and steel . . . valves for handling fluids or gases under a wide range of pressures . . . valves for replacement or new piping systems . . . just check our Catalog 30-A. It's yours for the asking. Send for it now.

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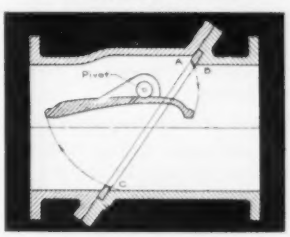


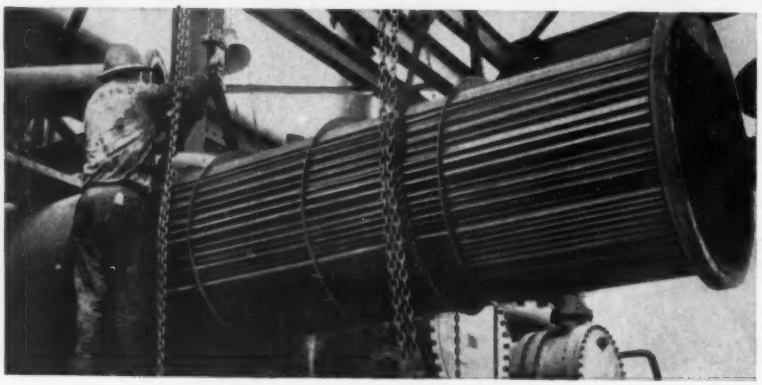
In open position, specially designed "airfoil" disc balances perfectly. No vibration. No flutter. When flow subsides, disc drops quickly and quietly to a tight closed position. No jarring. No slamming. No damage to system or valve. Note enlarged area around disc to insure low flow resistance.

BRIDGEPORT BRASS COMPANY

CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Replacing a copper alloy tube bundle after cleaning.

How to Reduce Exchanger Maintenance Costs by Using Performance Records

Although tube and shell heat exchangers fall into well-defined classes of design and operation, the variables in each exchanger situation make it an "individual" in respect to performance or corrosion failure. For this reason, comprehensive and continuing performance records on each exchanger are essential in achieving maximum operating efficiency and productivity.

Why Keep Records?

The primary purpose is to establish a performance pattern which will suggest a minimum though adequate maintenance schedule. Proper records should also help to detect variations in operating conditions which, though slight, may require significant changes in maintenance scheduling.

Tube Selection Important

Such performance records can also help determine whether or not the best exchanger design or tube alloy is being used. For example, although Bridgeport Arsenical Admiralty or Arsenical Muntz would ordinarily be indicated for saline or brackish cooling water, adequate records will often reveal that Bridgeport Duplex, Copper, Red Brass, Arsenical Aluminum Brass, Duronze IV or occasionally 70-30 Cupro Nickel would be more economical.

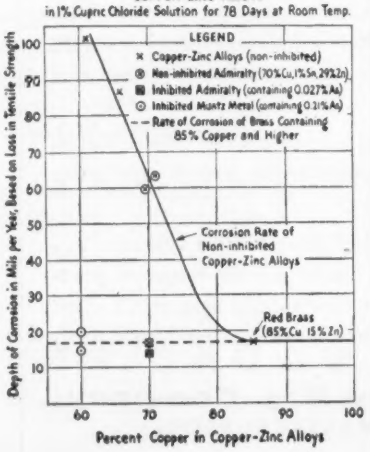
Preplanning and Scheduling

Another benefit in adequate record-keeping is in the preplanning of maintenance repairs. The nature and extent of the maintenance can be known and prepared for previous to shutdown, permitting servicing with minimum loss to operating time. Likewise, sufficient lead time can be allowed in ordering tube replacements or in obtaining qualified technical help in determining the proper tube alloy to use if this is indicated.

Watch Those "Variables"

A file of records does not in itself constitute a maintenance program. Instead, critical evaluation must be made of each report so that existing maintenance schedules may be confirmed or altered. A particularly keen eye should be kept on those variables not normally recorded by the operating staff. Minor changes in water composition or product streams may not be important in production, but may significantly affect fouling or corrosion rates. For instance, in petroleum refining and petrochemical processing, the hydrocarbons have virtually no effect on copper and its alloys. But the presence of sulfides, chlorides, acids, ammonia, gases and moisture influenced by variations in temperatures, velocity and pressure will have an important effect on corrosion. Thus, where conditions such as these are detected, and where operational adjustments are not feasible, consideration should be given to the use of the other copper-base alloys or Duplex tubing.

CORROSION RATE of INHIBITED and NON-INHIBITED COPPER-ZINC ALLOYS in 1% Cupric Chloride Solution for 78 Days at Room Temp.



Records Help Lick Dual Corrosion

Another advantage of adequate record-keeping is in high-lighting the need for maintenance-reducing techniques. For example, under some conditions, the use of higher grade components, such as Duplex tubes, proves economical when yearly costs are totaled up. The experience of one refinery demonstrates this point. In an exchange between ammonia and hydrogen sulfide bearing propane gas and river water, the continual failure of steel and red brass tubes made it necessary to retube the exchangers every one or two years. A change-over to Bridgeport Duplex Tubes—with low carbon steel on the product side and red brass on the water side—resulted in an average life of from 6 to 10 years.

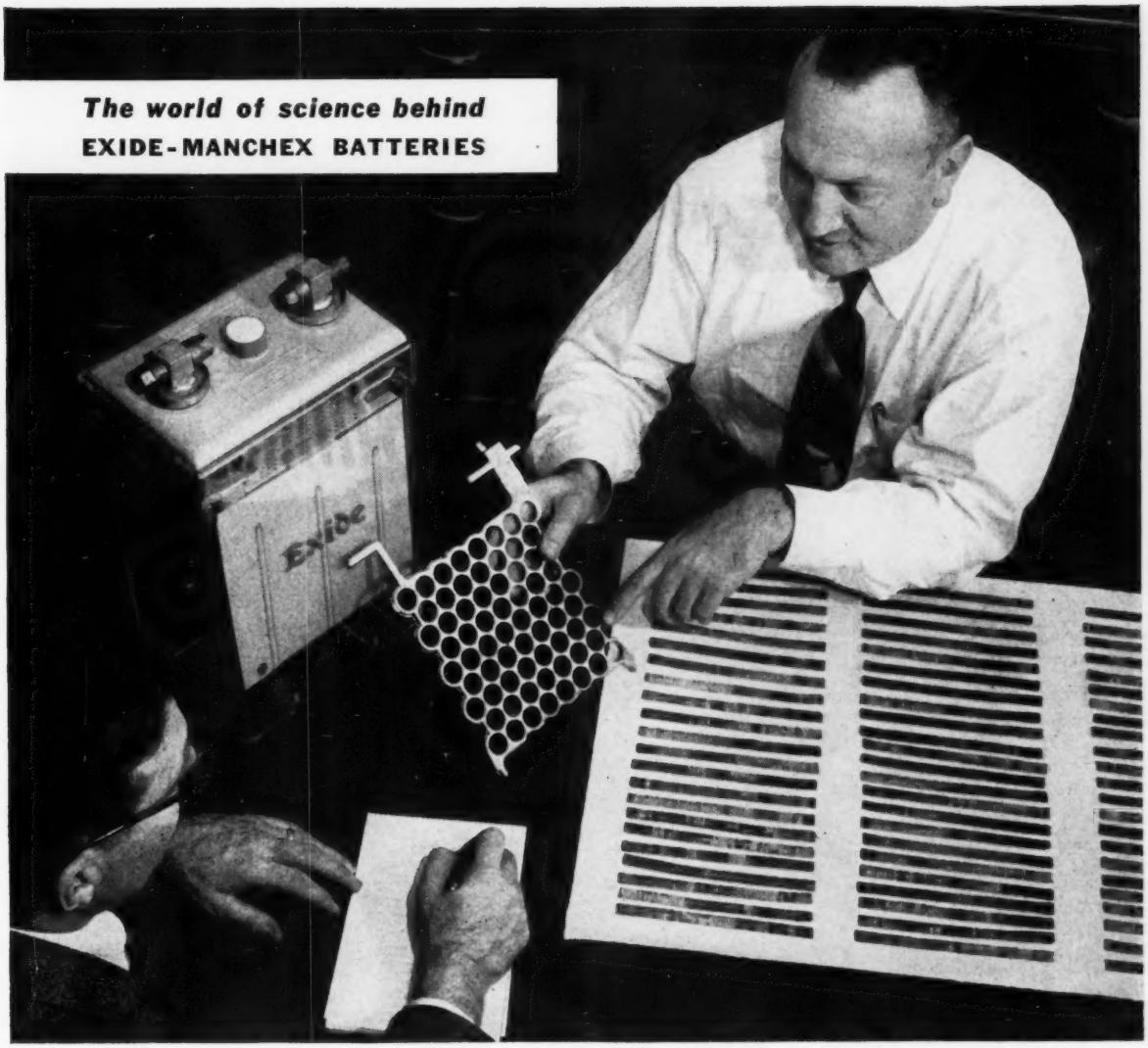
Technical Service

These are just a few of the advantages of keeping maintenance records on performance and how they can provide a clue toward solving your corrosion problems. For more specific help, the advice and experience of Bridgeport's Technical Service and Corrosion Laboratories are at your service through your nearest Bridgeport Sales Office. This service, plus Bridgeport's extensive selection of tubes and alloys, will enable you to meet your needs faster, easier and more economically. (842)

Further Help From Bridgeport's Condenser Tube Handbook

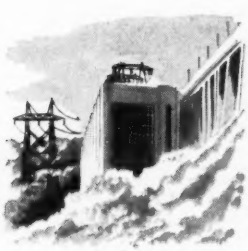
A wealth of practical detailed information on tube condensers and heat exchangers is contained in the Bridgeport *Condenser Tube Handbook*. Anyone concerned with the specifications, operation or maintenance of such units will find it an invaluable addition to his reference library. Write for your free copy.

The world of science behind
EXIDE-MANCHEX BATTERIES



Being interviewed is Dr. H. J. Strauss, Chief Product Engineer

"Plates last longer because they're 5 times bigger"



At the Exide Laboratories— **Reporter:** Just what are all those lead strips?

Strauss: Here we've taken the spiral lead buttons from a single Exide-Manchex positive plate and unrolled them on this table. This total area is actually five times the plate size.

Reporter: I see the strips are corrugated on one side. Is that to increase the surface area?

Strauss: Yes, and also to give the electrolyte free access into the interior of the spiral buttons.

Reporter: How does this feature affect battery performance?

Strauss: It means each part of the surface of the positive plate works easier to produce electricity. An Exide-Manchex can coast where many another battery is forced to strain. And the active material lasts years longer than it otherwise would.

Reporter: Is this construction available in any other battery?

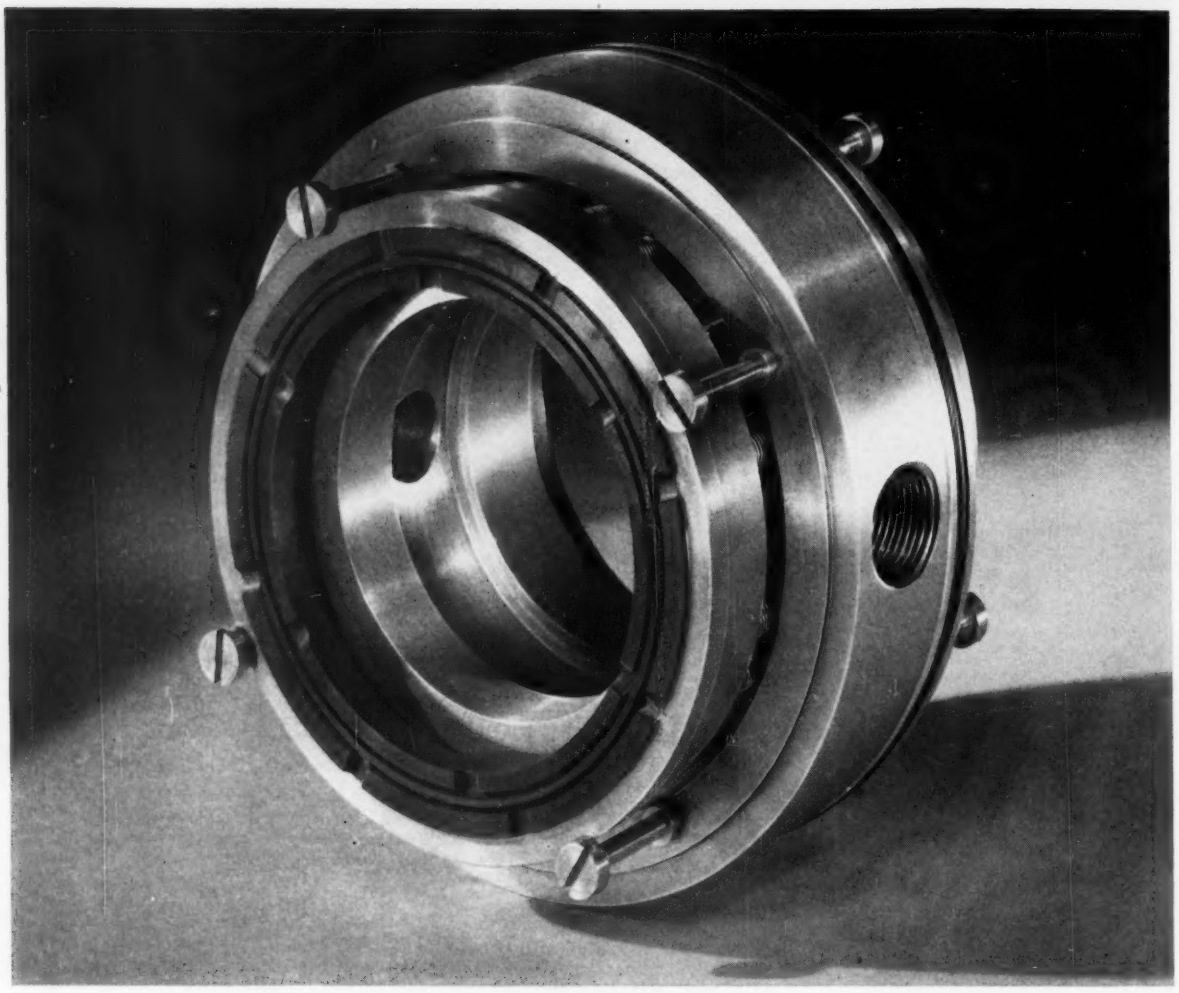
Strauss: No, only in the Exide-Manchex.

Reporter: Obviously this is an important feature of the Exide-Manchex Batteries.

Strauss: Yes it is, but it's only one of many engineering details that contribute to their long life.

Note to battery users: Whenever you order batteries for floating service applications or the equipment that requires such batteries, be sure to specify Exide-Manchex. Write for detailed bulletin. Exide Industrial Division, The Electric Storage Battery Co., Philadelphia 2, Pa.

THE ELECTRIC STORAGE BATTERY COMPANY **Exide**®



Koppers Face Type Seal Provides Up to 20,000 Hours of Service!

Up to 30,000 Hours in Laboratory Tests Using Clean Gas!

Koppers engineering has created an unmatched sealing surface that gives Koppers Face Type Seals a much longer-than-ordinary service life.

The exclusive design of the sealing surface keeps pressure distribution and hydraulic balance unchanged during operation . . . permits a light face loading which lowers interface temperatures. Hydraulic balance allows sealing of gases and liquids through a wide range of rubbing speeds. Rugged construction adds to Koppers long service life. Rotating collars can be of hardenable stainless steels, cutlery and die steels, Stellites, or of a hard chromium or carbide face. Ring is of carefully selected grades of carbon.

If you have a sealing or piston ring problem, Koppers entire research, production and engineering facilities are at your disposal. For more details, write to the KOPPERS COMPANY, INC., 2102 Hamburg St., Baltimore 3, Maryland.

Koppers Company, Inc.
Metal Products Division
Piston Ring and Seal Dept.

***Engineered* Products**
Sold with *Service*

KOPPERS®

MECHANICAL SHAFT SEALS

Building Water Treatment Systems *is a man-size job!*

Having been in the water conditioning business for nearly fifty years, we know that *every* water treatment job is a challenge. In this business, you can't send a boy to do a man's work.

Since 1908, Elgin has been designing, building and installing water conditioning equipment for thousands of purposes in hundreds of industries, institutions, municipalities and commercial establishments. Naturally, during that time, we've built up a backlog of experience and water engineering skill second to none. As a result, the name *Elgin* has become synonymous with superiority in the field of water conditioning — whether softening, dealkalizing, demineralizing, deaeration, degasification, chemical treatment.

Elgin makes it a policy to meet *every* water treatment problem with concentrated attention. You can feel sure — when you bring your problem to us — that all the experience and knowledge at our command will be at your disposal. Talk over your water treatment problems with your Elgin representative. Or write us direct. We *can* help you!

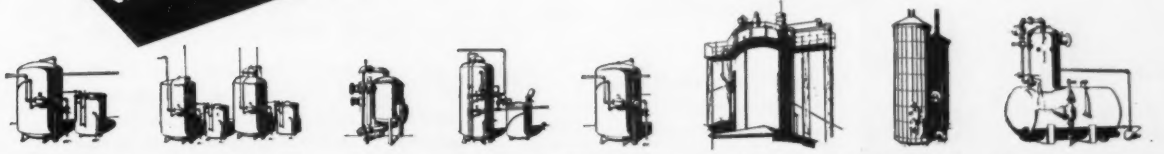
ELGIN WATER CONDITIONING SINCE 1908

ELGIN SOFTENER CORPORATION

130 No. Grove Avenue, Elgin, Illinois

Representatives in Principal Cities

In Canada: G. F. Sterne & Sons Ltd., Brantford

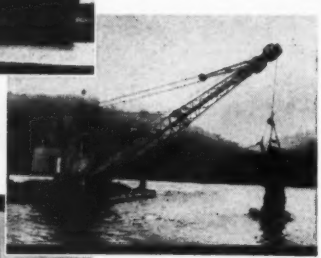


SOFTENERS ION EXCHANGERS FILTERS DEIONIZERS DEALKALIZERS LIME COAGULATORS DEGASITORS DEAERATING HEATERS

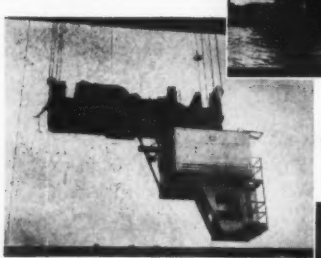
Two 12-ton ore bridges, built, designed and installed for a large steel company.

DRAVO HEAVY MATERIALS-HANDLING EQUIPMENT ...CUSTOM BUILT FOR YOU!

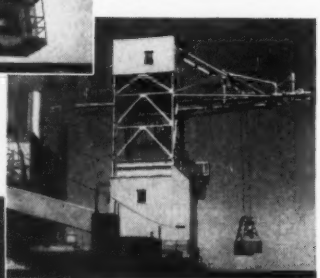
Travelling unloading towers built to handle imported iron ore at an Atlantic port.



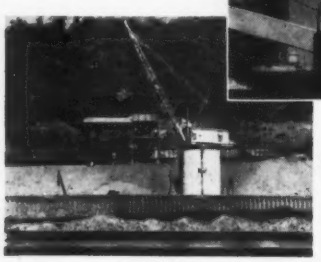
Whirler crane mounted on pontoon hull is used for dredging and general contract work.



Light-weight man trolley installation increased bridge handling capacity 60%.



Coal unloader designed and built for a large mid-western electric power company.



Stationary whirler crane designed and built to transfer coal from barges to hopper cars.

Over-all economical and safe performance is best obtained by using materials-handling equipment designed to suit your operating conditions. If you're planning a new materials-handling installation, we suggest an early "Round Table" session with Dravo engineers.

From actual experience over the past 60 years in building and installing the equipment shown here, valuable data is available in working out the features you want in your installation. This information, along with your own operating experience, can be used to create a design incorporating all the best features for easy maintenance, a high safety factor and simple, economical and satisfactory operation.

You can profit by taking advantage of this specialized "Round Table" service.

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YOU CONSERVE POWER INCREASE EFFICIENCY REDUCE MAINTENANCE

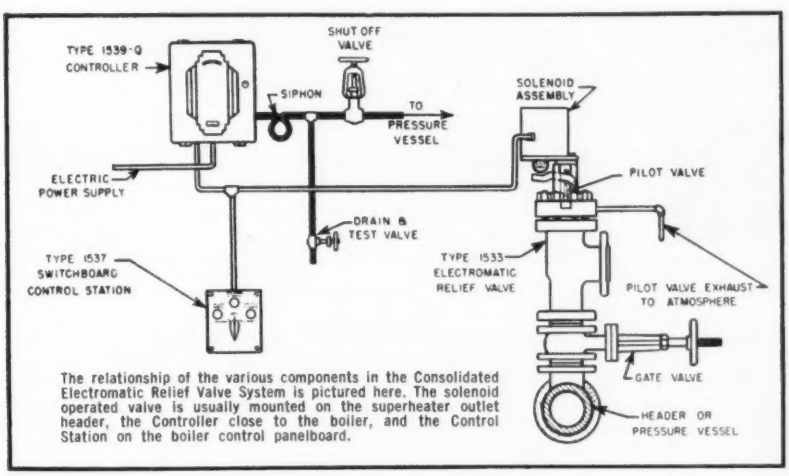
WITH THE CONSOLIDATED "ELECTROMATIC" RELIEF VALVE

The ideal auxiliary valve for steam generating plants with pressures to 2500 psi and temperatures to 1100° F., the Consolidated Electromatic Relief Valve relieves pressures precisely within close limits with "quick as a wink" cyclic action. It's an automatic, electrically actuated valve that can be accurately set for a differential of 1% or less between the opening and closing pressures.

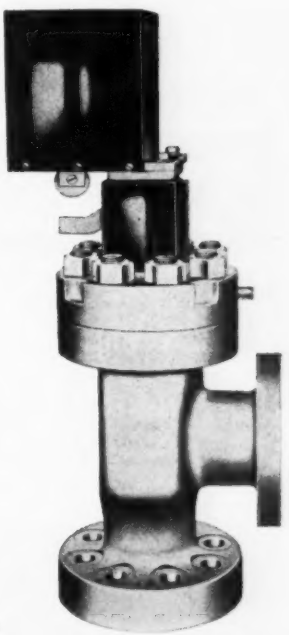
Operated by a solenoid actuated by a control station mounted in the panelboard, merely setting the switch provides automatic or manual service or cuts the valve out of operation. High superheat temperatures or other variables do not affect valve operation. A constant pressure output is maintained on the superheaters.

The Electromatic is also used to purge superheaters during start-up or as a superheater surge vent valve to reduce substantially the possibility of damage to equipment.

Wherever the Electromatic supplements spring-loaded safety valves, power is conserved, the efficiency of steam generating equipment is increased and maintenance is reduced. The Consolidated Electromatic Relief Valve is available in these sizes: 2½", 4", 10" and 14". Get complete specifications and operational details. Send for Bulletin 720.



The relationship of the various components in the Consolidated Electromatic Relief Valve System is pictured here. The solenoid operated valve is usually mounted on the superheater outlet header, the Controller close to the boiler, and the Control Station on the boiler control panelboard.

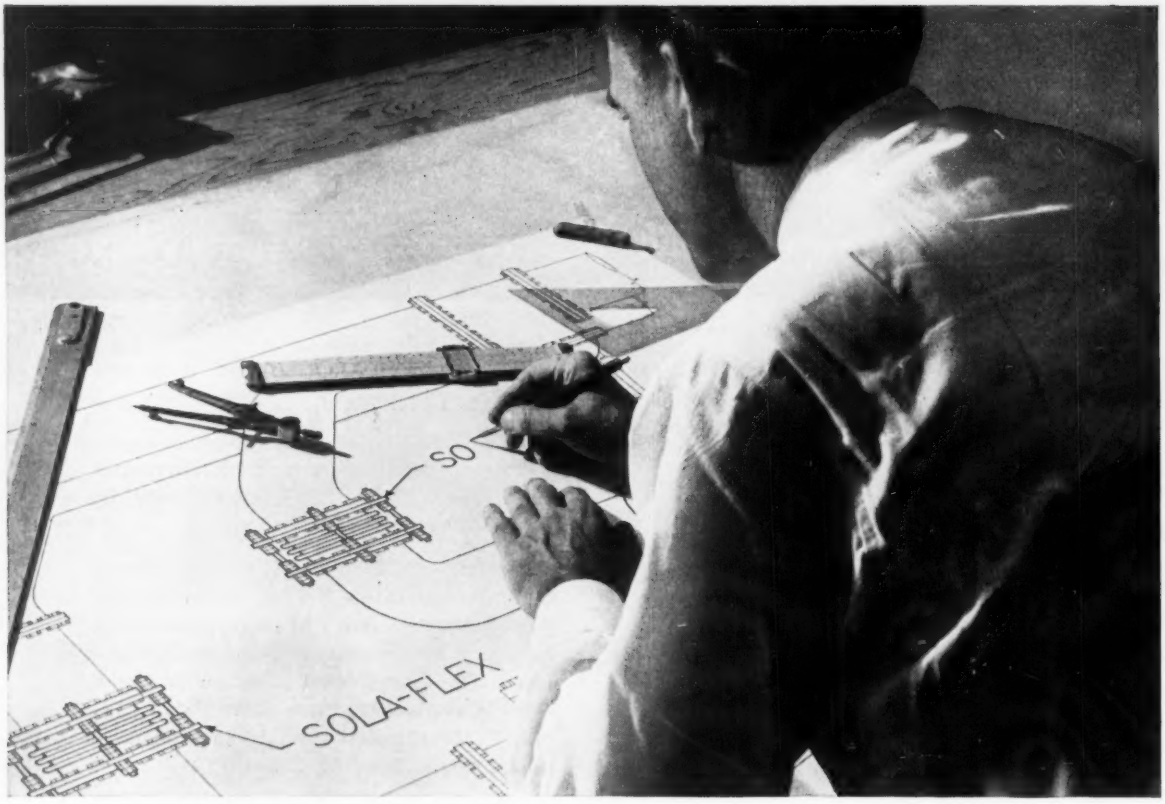


In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, CONSOLIDATED SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*



In piping "specs" specify Sola-Flex

•

SOLA FLEX®

EXPANSION JOINTS AND BELLOWS
MADE IN ALL SIZES AND VARIETIES

YOU BENEFIT many ways when you call for Sola-Flex expansion joints in a high or low pressure piping installation. Durable and economical, Sola-Flex joints are custom-engineered, based on advanced designs perfected by Solar. They are built of a variety of metals in a vast array of sizes, shapes and configurations. And Sola-Flex joints have been proven in service—in all types of installations throughout the petroleum, utility, chemical, petrochemical, and other industries.

Send for the latest Sola-Flex catalog—many pages of valuable data. Write Dept. C-125, Solar Aircraft Company, San Diego 12, California.

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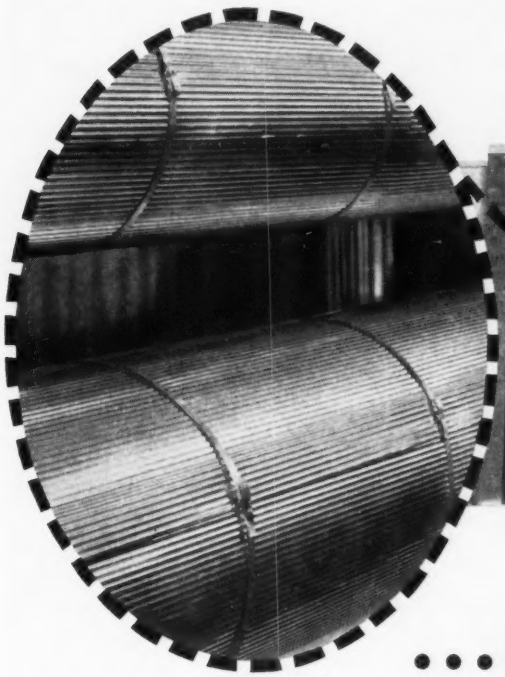
CHILDERS JACKETING...

Increases efficiency of insulation



Greenwood Mills, Greenwood, S. C., uses over 100,000 sq. ft. of .006" Childers Jacketing to protect insulated lines at its newly-completed Mathews Plant.

W. L. Bross, Chief Engineer at Greenwood Mills

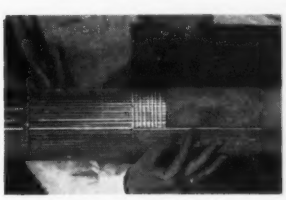
...protects insulated lines, decreases heat loss, improves appearance

Leading power plant engineers are discovering to their profit that insulation on steam lines *lasts far longer* when protected with Childers Aluminum Jacketing. This durable jacketing eliminates costly maintenance and repairs. It protects the insulation indefinitely against damage from workmen, equipment and dripping fluids like oil and grease. Outside lines covered with Childers Jacketing are safe from exposure to weather. Periodic inspection of the insulation is easy with the removal of any section of jacketing.

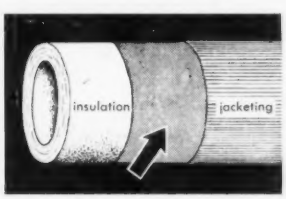
Childers Jacketing on power plant lines and equipment has the added benefit of *effectively reducing the heat lost by radiation.* Engineers have determined that Childers Jacketing improves the efficiency of insulation and therefore decreases fuel consumption. The result is fewer BTU's lost per KWH.

With Childers Jacketing, older power plants, as well as new, take on a trim, modern appearance. Unlike ordinary sheet aluminum, Childers Jacketing has a 3/16" cross corrugation rolled in it. This cross-crimping reduces glare, makes dirt less visible. Housekeeping is easier — your plant is always a credit to the community.

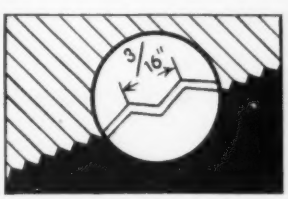
Write: Childers Manufacturing Co., Department P2, 3620 West 11th St., Houston 8, Texas.



LAP SEAL, available at no extra cost, is a series of 8 ribs rolled into the underlapping edge of the jacketing, providing an automatic measure of the 2" circumferential lap. Proper lap is insured without waste. Labor is saved. Where desired, a positive weather seal is easily made with Lap Seal and a mastic.



FACTORY-ATTACHED MOISTURE BARRIER protects the underside of aluminum from possible attack by alkaline solutions present in most insulating materials. The moisture barrier, bonded at the factory by continuous strip adhesive, adds little to cost, saves application labor, insures against underneath corrosion.

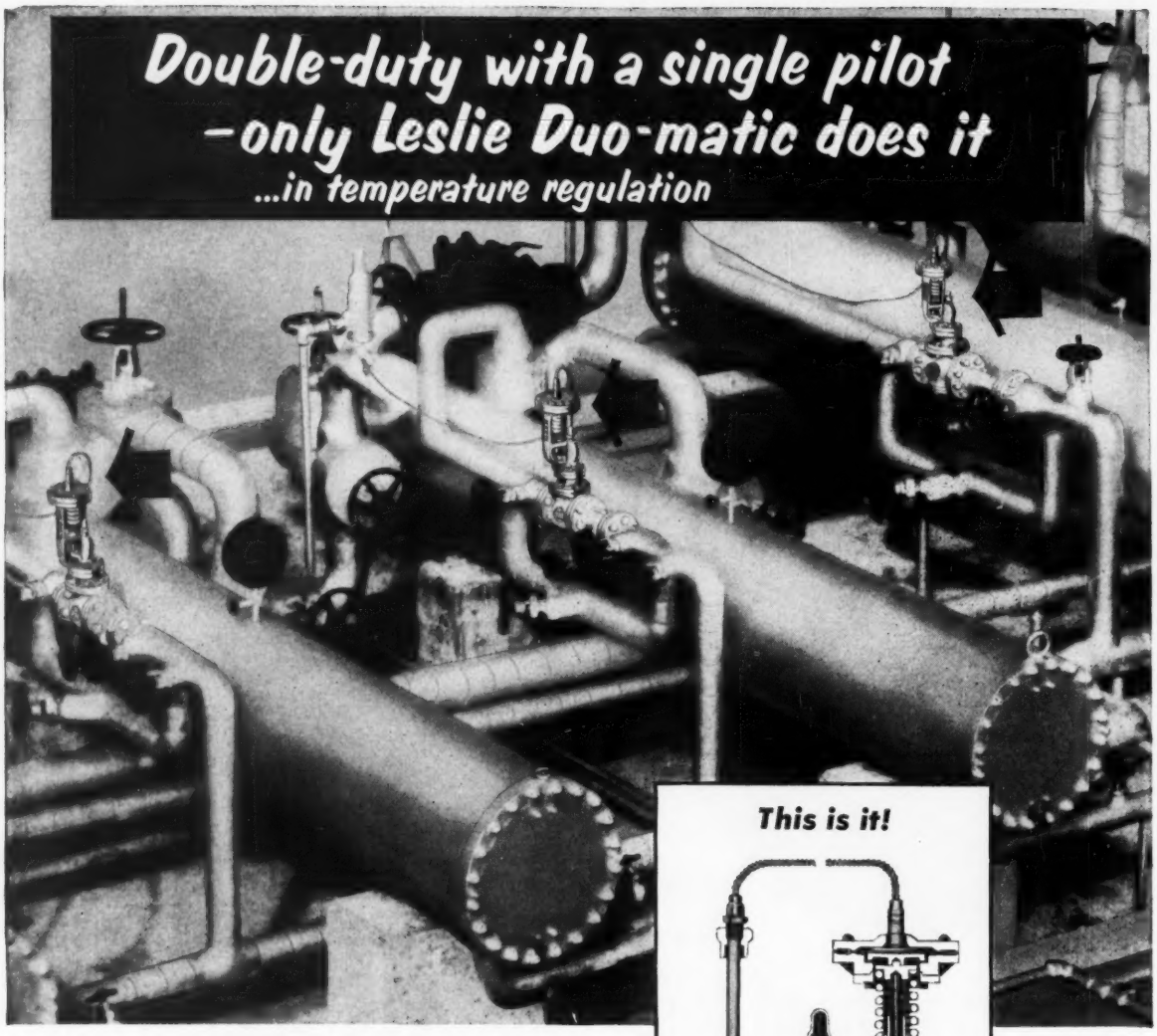


TESTS PROVE EXTRA STRENGTH of rolled-in 3/16" cross corrugation. Vertical strength and rigidity of a .016" sheet with this 3/16" cross corrugation are increased to that of a plain .024" sheet. Jacketing costs are consequently reduced by as much as 1/3 when Childers Jacketing is used instead of ordinary sheet aluminum.

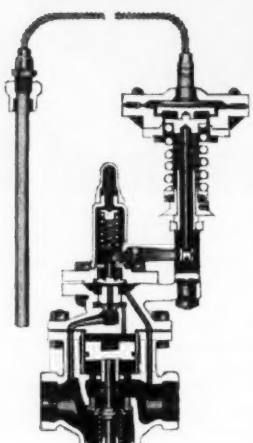
CHILDERS HEAVY WEIGHT ALUMINUM JACKETING is recommended for extra protection of lines along walkways and other areas subject to physical abuse. Also recommended for protection of insulated towers, vessels and tanks. Only Childers offers .019" Heavy Weight jacketing in labor-saving 4' wide rolls.

Double-duty with a single pilot —only Leslie Duo-matic does it

...in temperature regulation



This is it!



Leslie Class LTCO Duo-matic temperature and pressure regulator

The Duo-matic Leslie temperature regulator for controlling steam flow is a single unit, with a *single* internal pilot valve—yet it controls automatically both temperature and pressure conditions. No hunting or cycling on low flows . . . eliminates temperature "droop" on heavy loads.

Simplified piping and better control of fuel oil heaters, instantaneous and storage type heaters, driers, process heaters, kettles, open tanks, ovens, degreasing machines, steam tables, sterilizers, etc., more than offset the initial cost of this superior regulator.

Investigate "dual-function" Duo-matic regulators — proven in service for over 19 years of applications.

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REGULATORS AND CONTROLLERS

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of America's 100 largest industrial corporations are users of Clarage air handling and conditioning equipment.

CLARAGE FAN COMPANY
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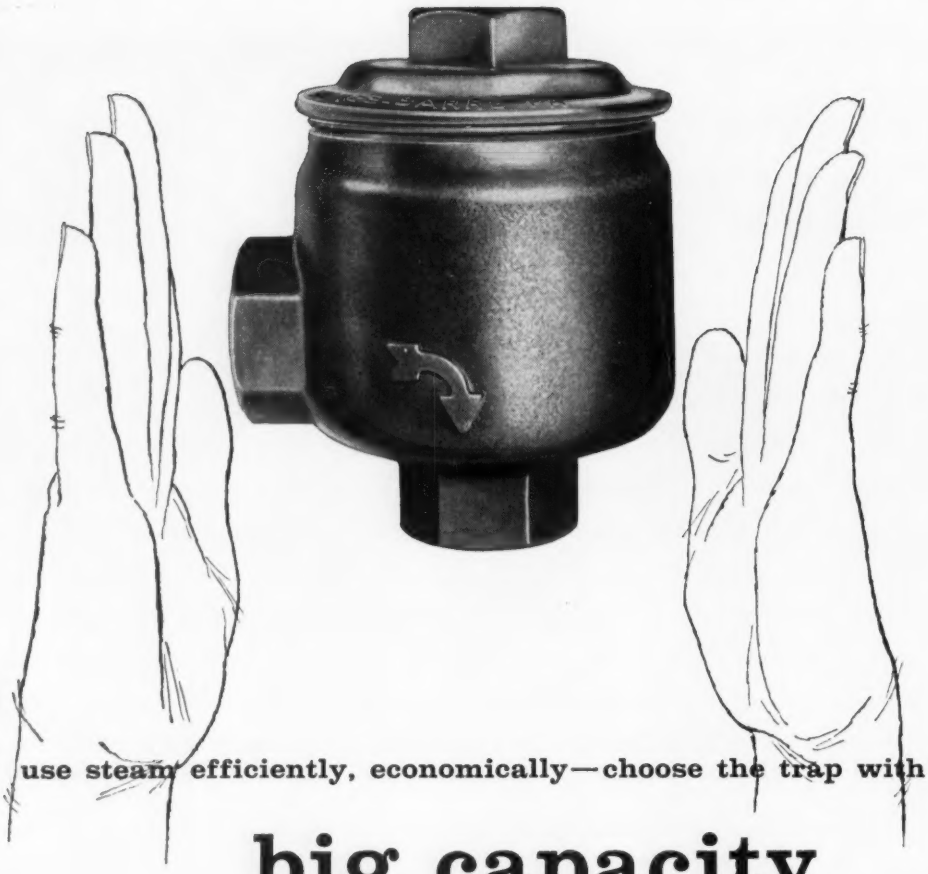
Source: The Fortune Directory • Published July 1956



use steam efficiently, economically—choose the trap with . . .

big capacity

. . . for faster discharge

All a steam trap does is discharge condensate and air from steam lines and equipment—no mystery about it. The bigger its capacity, the faster it can get rid of condensate. But its importance shouldn't be overlooked. On its effectiveness can rest your economical use of steam . . . the efficiency of your process operations.

You get this high capacity in Nicholson steam traps through effective use of a large orifice. And you get much more—simplicity of design and quality through and through.

- **One moving part**
- **Positive shutoff—no steam waste**
- **Powerful, intermittent valve action**
- **Each unit service tested**

Specify Nicholson, and be sure.

Write for new
Bulletin 10-55

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TRAPS • VALVES • FLOATS • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY

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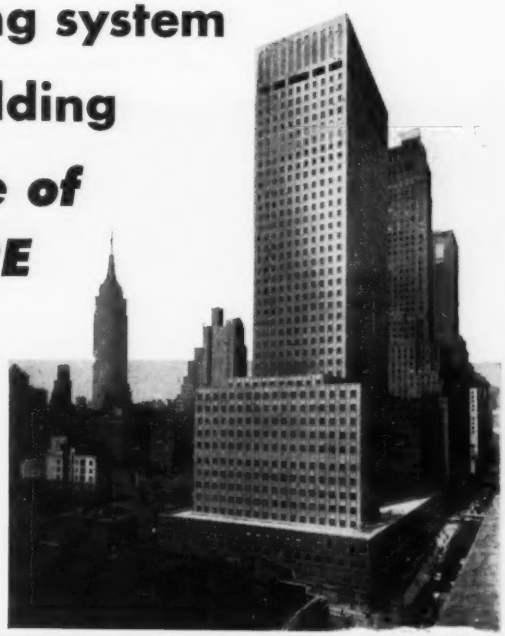
Ingenious air-conditioning system of Socony-Mobil Building *makes liberal use of* NATIONAL PIPE



Owner: GALBREATH CORP., JOHN W. GALBREATH AND PETER B. RUFFIN
Architects: HARRISON & ABRAMOVITZ
Associated Architect: JOHN B. PETERKIN
General Contractor: TURNER CONSTRUCTION COMPANY
Mechanical Engineers: JAROS, BAUM & BOLLES

This gleaming, 45-story, stainless-steel-sheathed building is the largest air-conditioned office building structure ever erected. Its remarkable air-conditioning system is powered by purchased steam, which is actually used twice. In the basement there is a refrigeration plant, consisting of 3 centrifugal steam turbine driven compressors of 2600-ton capacity. These 3 units are driven by steam turbines operating full condensing, with the exception of one which is a partial condensing and exhaust. This exhaust steam, by means of a 10-inch steam main, is tied in with the building's steam distribution system. This 10-inch main serves, during summer operation, all the steam requirements for the tempering coils in the air-conditioning system, as well as the steam required for three 500 Lithium Bromide Absorption Machines. In other words, the three 500-ton units act as a surface condenser for the exhaust steam—the building enjoying the economics of this ingenious piping layout.

Approximately 470 tons of USS NATIONAL Pipe—most of it Seamless—were used in the construction of the air-conditioning and heating systems. And at least 350 tons of NATIONAL Seamless were used in the huge building's plumbing system.

As is so often the case in designing complex plumbing and heating systems, the engineers selected NATIONAL PIPE. They knew from past experience that, no matter how rigorous the conditions, NATIONAL would do the job, and do it well.

If you'd like more information on the use of NATIONAL PIPE in plumbing and heating, air-conditioning and power installations—large or small, simple or complex—get in touch with us. Our experienced engineering staff is at your service.

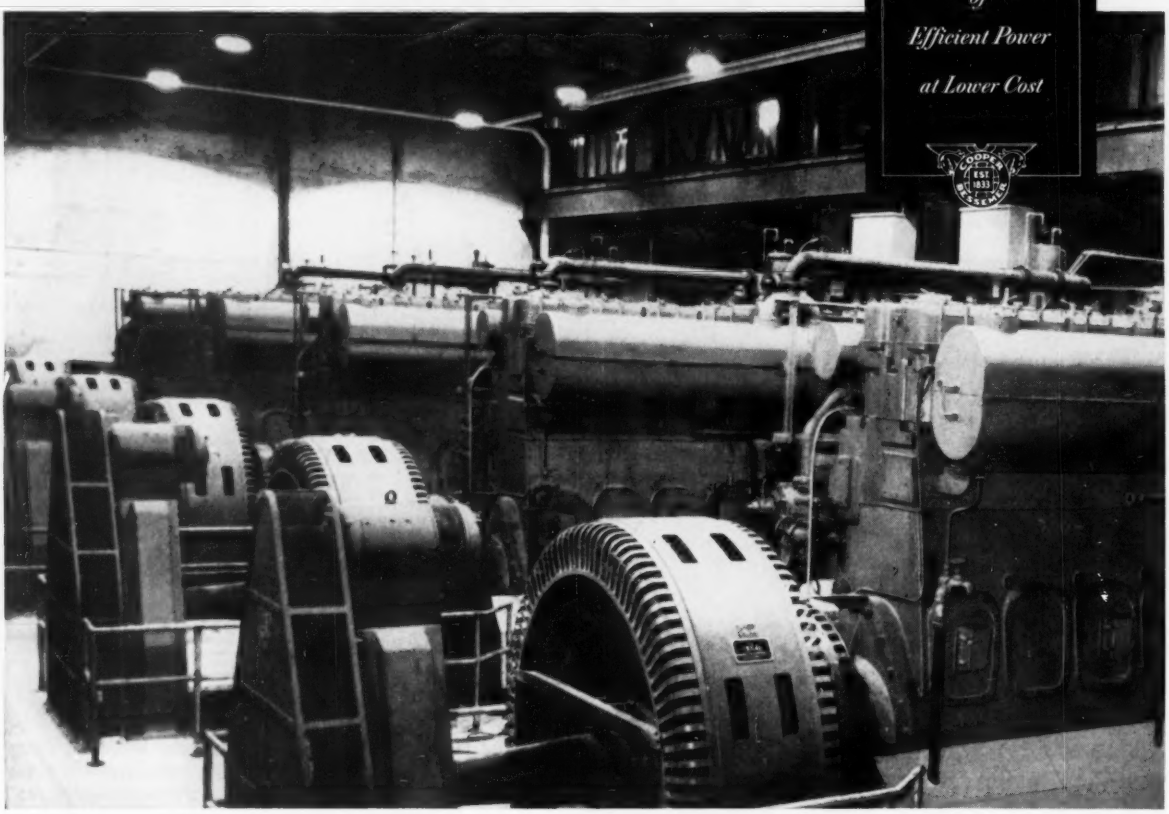
NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

NATIONAL PIPE

UNITED STATES STEEL

Cooper-Bessemer LS-8 Diesel engines with 15½-inch bore and 22-inch stroke . . . trouble-free service for the U. S. Air base at Keflavic, Iceland.

Another Example of Efficient Power at Lower Cost



COOPER-BESSEMER DIESELS . . .

"On Target" Power Source For Far North Air Base

RIGHT "on target" is a pretty good way to describe both the application and performance of five Cooper-Bessemer LS Diesel engines at the Keflavic, Iceland, U. S. Air base.

These 4-cycle, turbocharged Cooper-Bessemer Diesels, each directly connected to a 1250-kw generator, provide dependable electric power that assures safe, uninterrupted operation of the entire base. Rated 1760 hp at 327 rpm, these 8-cylinder LS engines have a reliability record of delivering efficient, low cost power even under the most severe operating conditions.

You'll find Cooper-Bessemer offers a wide range of heavy-duty engines for stationary, mobile and marine application — Diesel, gas or gas-diesel — with one especially suited to handle your powering requirements right "on target". For further details and specifications, contact the nearest Cooper-Bessemer office listed below. Their many years of engineering experience is always at your disposal.

MOUNT VERNON, OHIO
COOPER-BESSEMER
GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper-Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

you, too, could spend a lifetime studying **HEAT EXCHANGER TUBE** problems...

but there's an **easy** way to save yourself that kind of work

Simply pick the brand of Heat Exchanger Tube that starts out in life as a CONTINUOUS-CAST billet . . . Scovill Phosphorized Admiralty. Only in Scovill's unique continuous casting process do *many* carefully controlled melts of alloy BLEND together in the casting process to produce such SOUND and UNIFORM billets for subsequent hot extrusion and cold-drawing into Heat Exchanger Tube. Exceptional uniformity of chemical composition and uniform distribution of the inhibitor (phosphorus) mean longer tube life.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

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HEAT EXCHANGER TUBE FOR APPLICATIONS FROM MARINE TO PETROCHEMICAL . . . FROM COMPRESSOR INTERCOOLERS TO "CAT-CRACKER" EXCHANGERS . . . IN THESE POPULAR ALLOYS
Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Naval Brass • Red Brass, 85% • Deoxidized Copper Arsenical Copper • Cupro Nickel 10%—20%—30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

ISC57

(Advertisement)

GAS CLEANING NEWS

Eastern Public Utility Installs Two More Koppers Electrostatic Precipitators to Remove Fly Ash

Major Utility has installed 8 Koppers Electrostatic Precipitators since 1947

YEARS of cost-saving, highly efficient performance preceded this latest installation of Koppers Electrostatic Precipitators. During these years, this leading Eastern public utility was able to judge Koppers by on-the-job operation—the most positive proof of performance.

Proves Performance on the Job

Ten years ago, this company purchased its first two Koppers Electrostatic Precipitators for fly ash removal. Satisfactory performance and low maintenance costs justified the purchase of additional Koppers units that were installed in a total of 4 stations. The eight units furnish highly effective, trouble-free operation in a varying range of CFM capacities.

Supplies a Wide Range

The eight Koppers Electrostatic Precipitators serve boilers ranging in capacity from 570,000 #/hr to 950,000 #/hr. Guaranteed efficiency runs as high as 98%, depending on the need of each application. This ability to engineer for a wide range of capacities enables Koppers to satisfy the needs of each station.

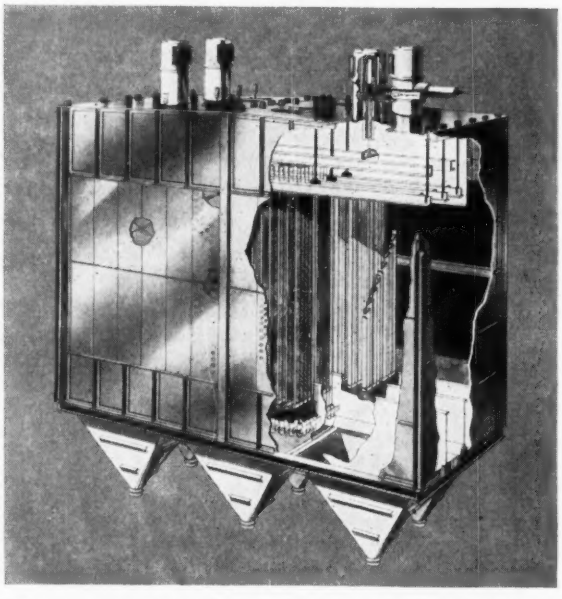
Meets Individual Plant Needs

Koppers custom-designs each Electrostatic Precipitator. Koppers units remove boiler fly ash before the flue gas is discharged from the stack. In designing Electrostatic Precipitators, Koppers utilizes its knowledge of the characteristics of various coals, types of boilers and methods of firing.

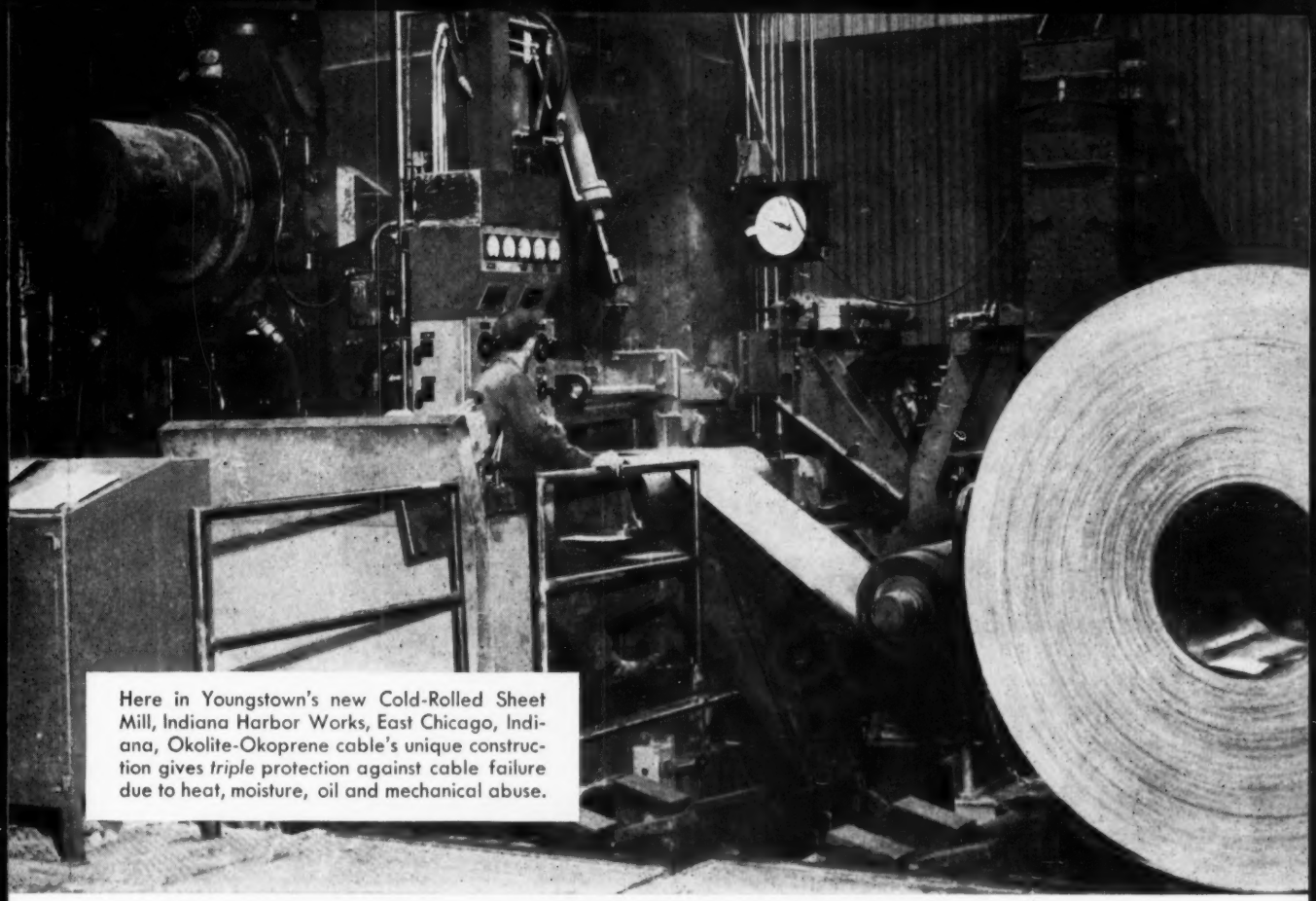
Backed by Know-How

Koppers gas cleaning experience goes back 75 years. This experience is backed up by extensive research facilities at Verona, Pa., and Baltimore, Md. From this experience and research has come gas cleaning equipment for all sizes and types of plants.

Get the most out of your gas cleaning dollar. Write KOPPERS COMPANY, INC., Metal Products Division, Industrial Gas Cleaning Dept., 4802 Scott Street, Baltimore 3, Maryland.



This cutaway photo of a Koppers Electrostatic Precipitator shows shell, vibrators, and collecting and discharge electrodes. The actual design and arrangement of elements vary widely because Koppers Electrostatic Precipitators are custom-engineered to fit the requirements of each installation.

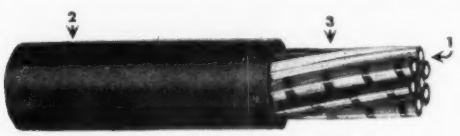


Here in Youngstown's new Cold-Rolled Sheet Mill, Indiana Harbor Works, East Chicago, Indiana, Okolite-Okoprene cable's unique construction gives *triple* protection against cable failure due to heat, moisture, oil and mechanical abuse.

how OKOLITE-OKOPRENE CABLE *gives Youngstown triple protection against control circuit failure*

The Youngstown Sheet and Tube Co. has Okolite-Okoprene control cable installed in its Indiana Harbor Works.

Here's how Okolite-Okoprene construction provides *triple* protection against the four main causes of steel mill cable failure—heat, moisture, oil and mechanical abuse.



Okolite-Okoprene Control Cable

1. Okolite insulation is applied to each individual conductor by the strip-insulating process. This insulation provides 30 year service-proved electrical characteristics, heat resistance and moisture resistance—so necessary for steel mill installations.

2. A tough Okoprene sheath, applied over the entire cable assembly, provides superior resistance to heat, moisture, oils, many acids, alkalies and chemicals and mechanical damage.

3. In addition to the heavy overall Okoprene sheath, a uniform wall of Okoprene is applied by the strip-insulating process over every individual insulated conductor. Thus, all conductors have *two* neoprene sheaths to resist water, grease and vibration . . . conditions so common in steel mill operations.

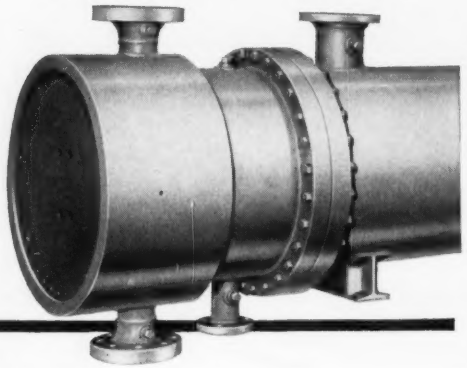
For complete information on Okolite-Okoprene cable, including engineering data, write for Bulletin PW-1085. The Okonite Company, Passaic, N. J.

where there's electrical power . . . there's **OKONITE CABLE**

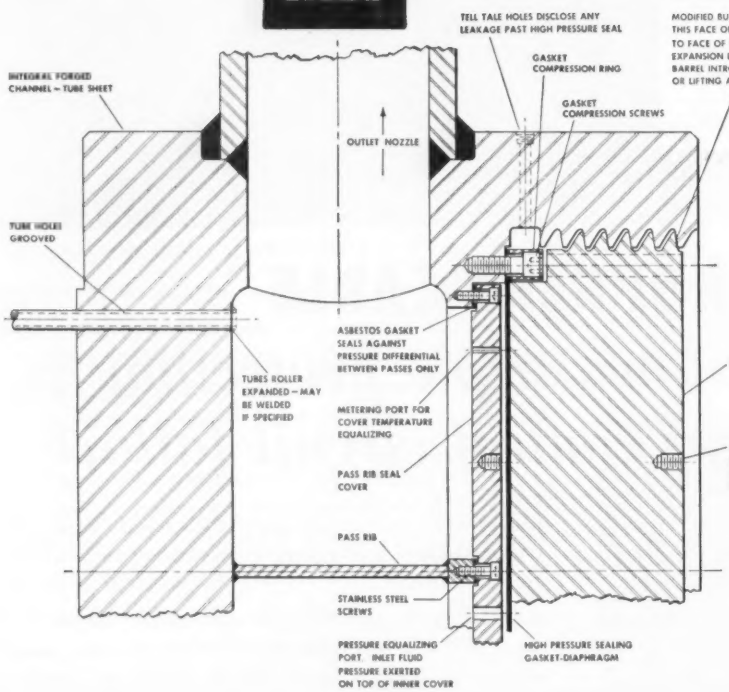
INSIDE FACTS

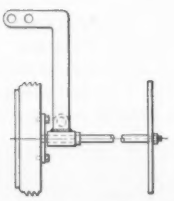
on the simplicity, safety and operating advantages of the exclusive Ross High Pressure Closure Design*

- Simpler design.
- Fewer parts to handle.
- High pressure seal unaffected by hydrostatic loads.
- Greater safety factor.
- Sudden load fluctuations no problem.
- Outer cover cannot corrode and bind . . . easily removed.
- Easily opened for inspection.

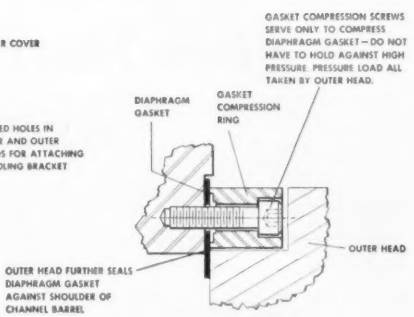


ROSS

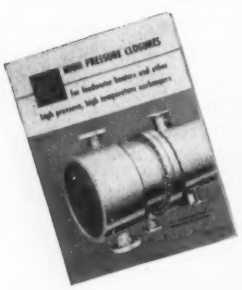

TELL TALE HOLES DISCLOSE ANY LEAKAGE PAST HIGH PRESSURE SEAL
GASKET COMPRESSION RING
MODIFIED BUTTRESS THREAD. THIS FACE OF THREAD PARALLEL TO FACE OF HEAD. DIFFERENTIAL EXPANSION BETWEEN HEAD AND BARREL INTRODUCES NO WEDGING OR LIFTING ACTION IN HEAD.
INTEGRAL FORGED CHANNEL – TUBE SHEET
GASKET COMPRESSION SCREWS
OUTLET NOZZLE
TUBE HOLES GROOVED
ASBESTOS GASKET SEALS AGAINST PRESSURE DIFFERENTIAL BETWEEN PASSES ONLY
OUTER COVER
TUBES ROLLER EXPANDED – MAY BE WELDED IF SPECIFIED
METERING PORT FOR COVER TEMPERATURE EQUALIZING
TAPPED HOLES IN INNER AND OUTER HEADS FOR ATTACHING HANDLING BRACKET
PASS RIB SEAL COVER
PASS RIB
STAINLESS STEEL SCREWS
PRESSURE EQUALIZING PORT. INLET FLUID PRESSURE EXERTED ON TOP OF INNER COVER
HIGH PRESSURE SEALING GASKET-DIAPHRAGM



TYPICAL COVER HANDLING BRACKET FOR HORIZONTAL UNIT


GASKET COMPRESSION SCREWS SERVE ONLY TO COMPRESS DIAPHRAGM GASKET – DO NOT HAVE TO HOLD AGAINST HIGH PRESSURE. PRESSURE LOAD ALL TAKEN BY OUTER HEAD.
DIAPHRAGM GASKET
GASKET COMPRESSION RING
OUTER HEAD
OUTER HEAD FURTHER SEALS DIAPHRAGM GASKET AGAINST SHOULDER OF CHANNEL BARREL

DETAIL OF GASKET COMPRESSION RING FACING



NOW FOR ALL THE DETAILS, request new Bulletin 5.6K1, mailed immediately. Write Ross Heat Exchanger Division of American-Standard, Buffalo 5, N. Y. In Canada: American-Standard Products (Canada) Limited, Toronto 5, Ont.

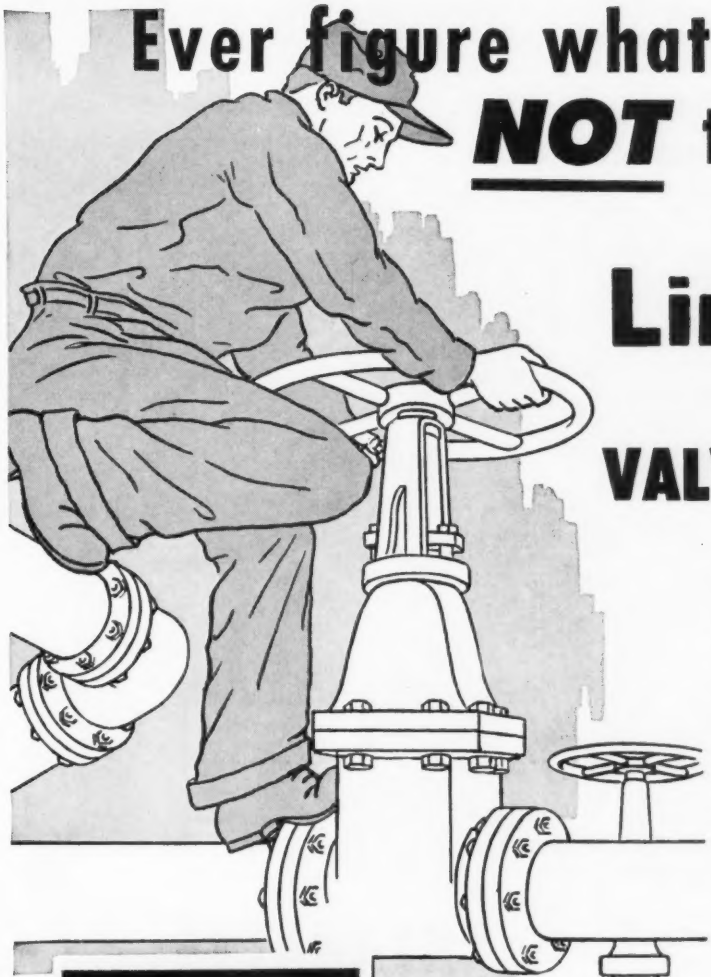
ROSS HEAT EXCHANGER

Division of AMERICAN-Standard

*for feedwater heaters and other high pressure, high temperature exchangers

Ever figure what it costs **NOT** to use

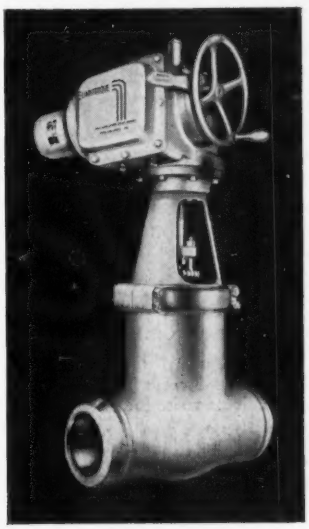
LimiTorque® *Automatic* VALVE OPERATION?



How much does opening and closing Valves *by hand* cost you—in man-hours—in physical danger to workmen who must climb to high or dangerous locations?

How much time, labor, and money could be saved in your plant by opening and closing valves *automatically*—at correct operating speeds—by the mere "push of a button"? With LimiTorque, one finger does the work of many hands. LimiTorque control permits one man to operate, and know the exact position of each valve from a central, conveniently located control panel.

LimiTorque protects valve seats, discs and stems from damage, by automatically shutting-off power source, should an obstruction interfere with valve closing. Valves operated by LimiTorque are always seated tightly, because the seating thrust of valve disc is accurately maintained in each closing-cycle, due to the patented torque limiting mechanism.



LimiTorque is, by far, the most widely used valve operator in the World... Send for complete new Catalog L-550, on your Business Letterhead.

LimiTorque®

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

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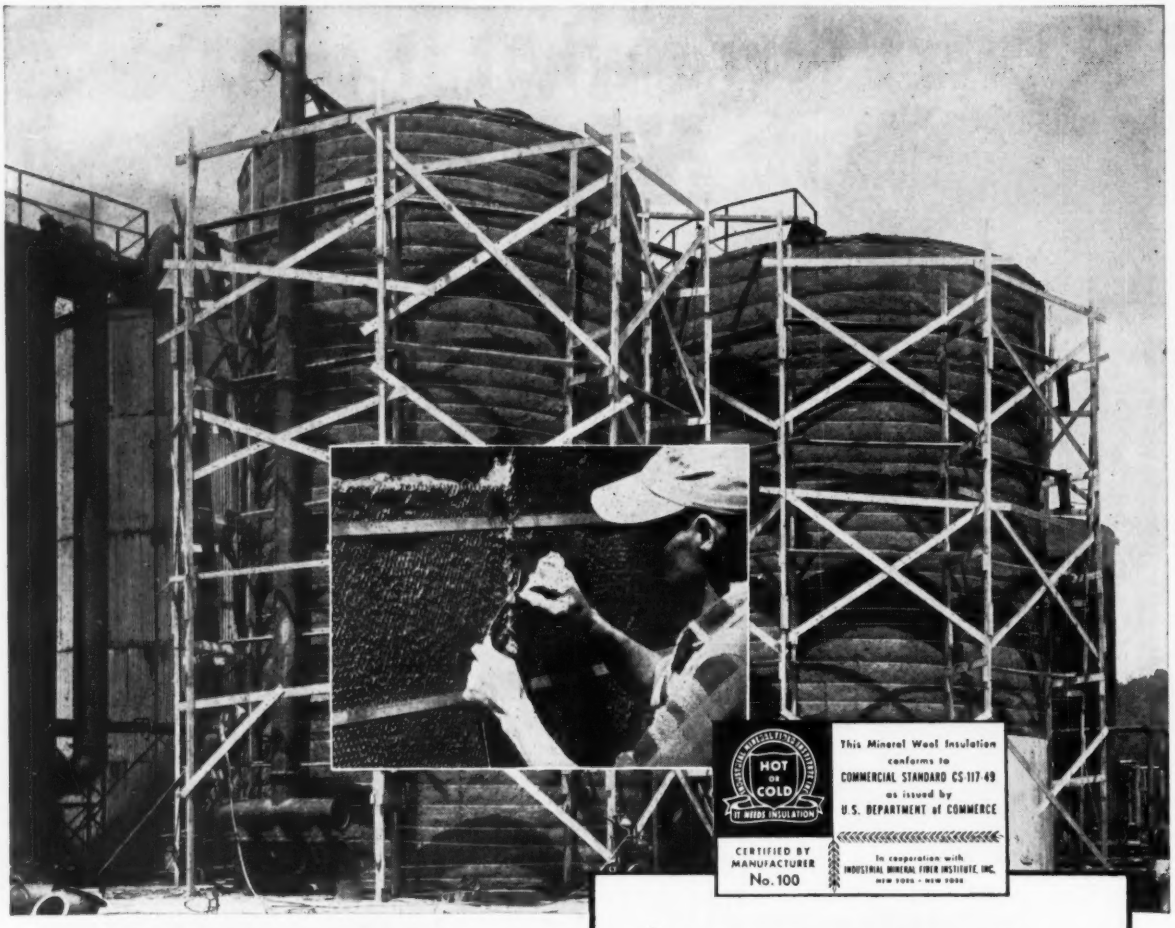
HOT or COLD
IT NEEDS INSULATION
This Mineral Wool Insulation conforms to COMMERCIAL STANDARD CS 117-49 as issued by U.S. DEPARTMENT of COMMERCE
CERTIFIED BY MANUFACTURER No. 100
In cooperation with INDUSTRIAL MINERAL FIBER INSTITUTE, INC.

BALDWIN-HILL *Spun Mineral Wool* BLANKETS

the logical choice for insulating large areas *Easily Quickly Permanently*

- Large, easy-to-handle B-H insulating Blankets are made of spun mineral wool fibers felted between different types of metal fabrics.
- Their flexibility facilitates application to large or small curved or irregular surfaces.
- Resistant to moisture or corrosive fumes; will withstand normal vibration without breaking down.
- Fibers of one blanket interlock with adjacent blankets, completely enveloping equipment without breaks or joints; effective up to 1200° F.

See our catalog in Sweet's Plant Engineering File or write for a copy.

BALDWIN-HILL COMPANY
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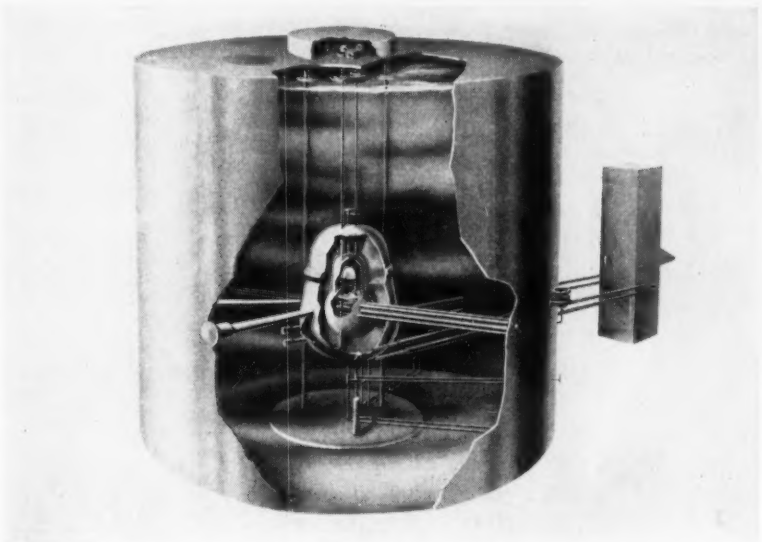
COMPLETE LINE OF BALDWIN-HILL INSULATING PRODUCTS

B-H Mono-Block	B-H Super Powerhouse Cement	B-H No. 100 Pipe Insulation
B-H Blanket	B-H No. 1 Insulating Cement	B-H 85% Magnesia Pipe Insulation
B-H Koldboard	B-H No. 52 Asbestos Cement	B-H Calcium Silicate Pipe Insulation
B-H Bond-Tite	B-H Spun Felt Insulation	B-H Mono-Kover Pipe Insulation
B-H Weatherseal	B-H Fine-Fyber Felt Insulation	B-H Spun Mineral Wool Fill

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

One-man Laboratory Reactor designed for industry, hospitals and schools—available for $55,000*

A new atomic tool that will speed and broaden nuclear research and training has been designed and developed by ATOMICS INTERNATIONAL. Here is a low cost instrument that even a moderately-budgeted hospital, industrial or educational laboratory can use to teach and conduct research in nuclear science.



New Laboratory Reactor provides a neutron flux of 10^{7}, a gamma ray flux of 10^{6}.

The Laboratory Reactor (LR) is a 5-watt, solution-type nuclear reactor. It can be operated and maintained by one person. It is 8-feet high, 8-feet in diameter. Power requirements are 110-volts at 60 cycles. It is completely fabricated at the factory and shipped as a unit—manufactured and installed in about 6 months. It has a wide range of applications.

As a laboratory instrument for research programs, the LR permits qualitative analysis by the neutron activation method—including measurement of coatings on metals, moisture testing, and liquid level monitoring. It will produce more than 100 different radioisotopes, about 40 of which have half-lives short enough to eliminate the need for costly contamination controls and waste handling systems.

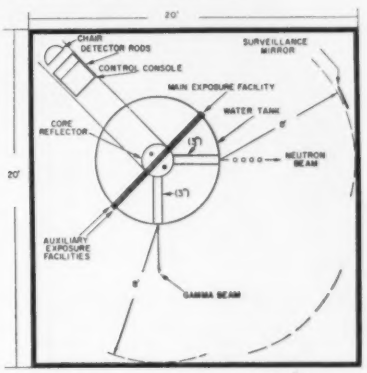
The LR can perform medical research functions such as genetic mutation studies, tracer research on plants and animals, radiation chemistry, and testing by the danger coefficient method. Equipped with facilities to conduct several experiments simultaneously, the reactor is ideally suited as a teaching tool in nuclear engineering, nuclear physics, radiochemistry and radiobiology. The basic behavior of neutron chain reactions, response to control elements, and the effect of delayed neutrons are a few of the 40-odd experiments that can be performed on the Laboratory Reactor.

The core of the reactor is a stainless steel sphere with an overhead convection recombiner. The fuel is uranyl sulphate enriched in uranium 235. The core is enclosed in a 6-inch lead reflector-shield. The complete 3500-pound unit—32" high, 24" wide—is centered in an 8-foot tank filled with water which serves as a biological shield.

The gas recombining system is contained in the core tank. A cylindrical screen above the core solution holds platinized alumina catalyst pellets which recombine hydrogen and oxygen gases formed during reactor operation. These fission product gases—valuable in experimental programs—can be withdrawn from the core through special gas lines.

The LR operator handles all controls and detection equipment from a control console adjacent to the reactor. Two cadmium control rods move vertically through the core—driven by electric motors manually controlled by the operator. The lead-weighted rods are attached to an electromagnet which releases automatically to let the rods fall by gravity into the core and shut down the reactor in event of a scram.

Instrumentation provides safety, low-cost and flexibility. At startup, three boron-lined neutron counters are fully inserted in detection tubes in the water tank. As power level increases, the operator withdraws the counters. Rate circuits—adjusted in response time constants—provide two ¼-second circuit channels for safety and observation and one 2-second channel for accurate power recording.



The LR can be installed in a 20x20-foot floor area.

ATOMICS INTERNATIONAL, a division of North American Aviation, Inc., is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. If you are interested in the LR—or any phase of reactor development—ATOMICS INTERNATIONAL is staffed and equipped to serve you. Please write, Director of Technical Sales, Dept. PW-71, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

*F.O.B. LOS ANGELES

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

"Air flow" design prevents cavitation in Butterfly Valve

Throttling water at a high rate of flow may cause critically high velocities through the restricted area and develop a vapor pocket immediately down stream of the valve. The alternate buildup and collapse of this vapor pocket develops supernormal pressures on the face of the valve disc, accelerating erosion and causing shocks in the piping system. This phenomenon, known as cavitation, may occur regardless of the shape of the valve disc or its material of construction.

This unusual problem arose in planning the Pleasant Valley Hydro-electric Plant. Although ultimately intended for open-shut service, the 96" penstock intake valve would have to throttle flow through the waterway during the plant construction period. Pratt engineers knew from experience that cavitation would probably occur and sought to forestall damage to the valve disc and pipeline structure.

The problem was solved with a design which allows atmospheric air to pass down the valve shaft and out through holes in the valve disc, preventing the formation of low pressure areas.

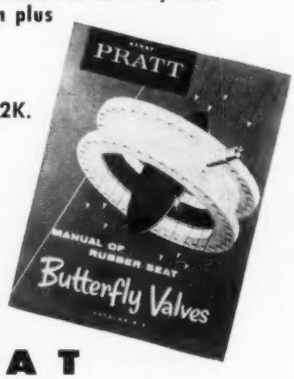
The valve and reducer are under 65 feet of water and the electric motor operator is on a floor 68 feet above the valve centerline. An oil-filled standpipe balances pressure in the reducer with outside water pressure.

This imaginative engineering is the result of 30 years experience in butterfly valve design. Specifying Pratt valves puts this experience to work for you. It helps keep installation costs down and assures years of efficient, economical operation.

96" valve for penstock intake at Pleasant Valley Hydro-Electric Power Plant, Los Angeles, Cal. ENGINEERS: Los Angeles Department of Water and Power.

NEW! Latest, most accurate pressure drop and flow data, conversion tables, discussion of butterfly valve theory and application plus other technical information.

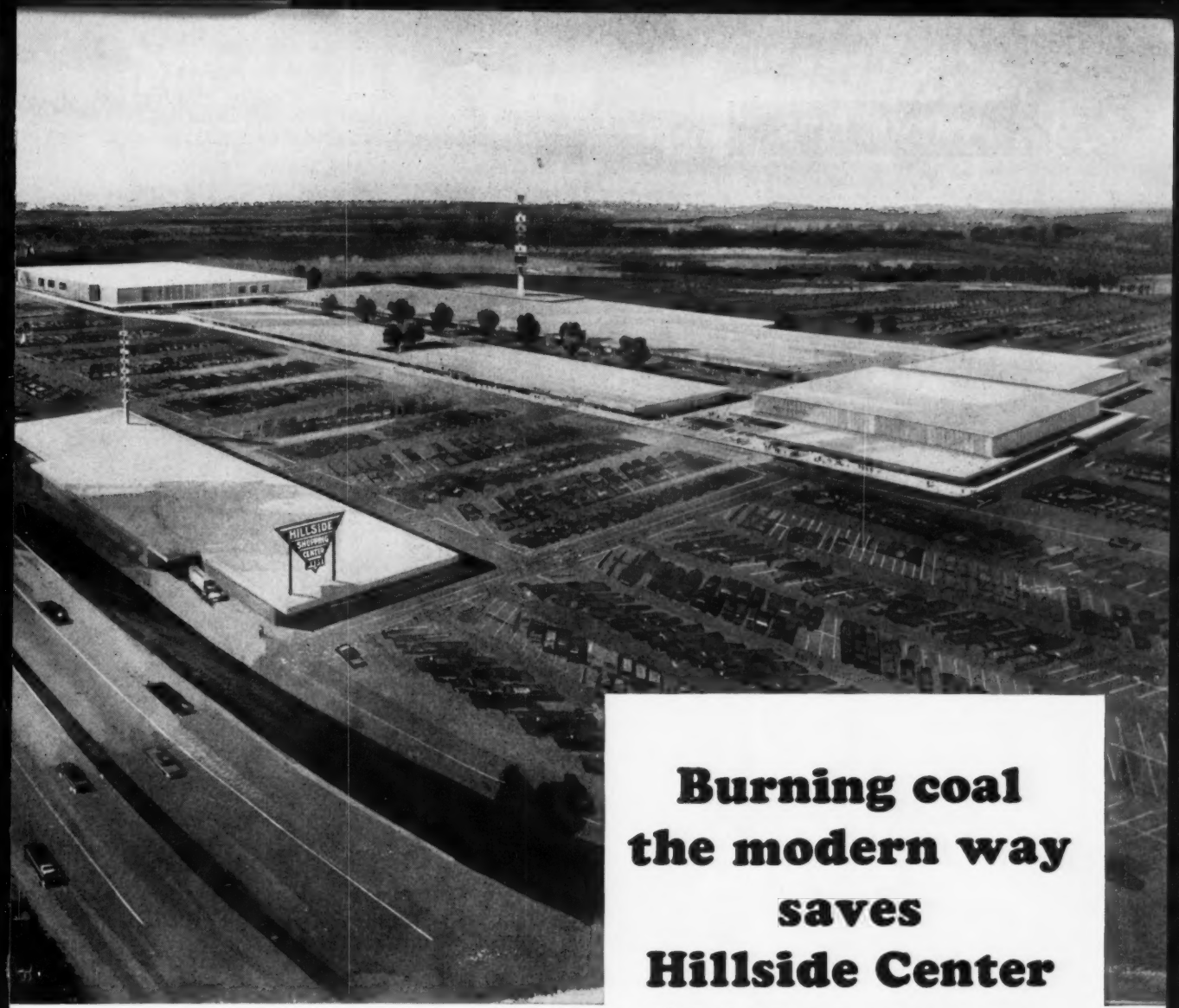
Write for Manual B-2K.



HENRY PRATT

RUBBER SEAT Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities



Burning coal the modern way saves Hillside Center $26,000 a year

The new Hillside Center, Chicago, Ill., is one of the country's largest and most modern shopping centers. Situated on a 59-acre site, it contains over 70 stores and offers parking space for nearly 5,000 cars. When Hillside Center was planned, exhaustive studies were made of prospective fuels . . . and it was decided to burn coal the modern way. For one thing, the initial economy of the mechanical system indicated coal. The cost of a complete coal system—boilers, coal and ash handling equipment, controls, etc.—fell within budget limitations. And, in view of limited space, the compactness of the system was an additional inducement. Finally, boiler room labor costs are at a minimum and actual operation savings with coal, compared to other fuels, is estimated at $26,000 a year.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

BITUMINOUS COAL INSTITUTE
Southern Building • Washington 5, D. C.

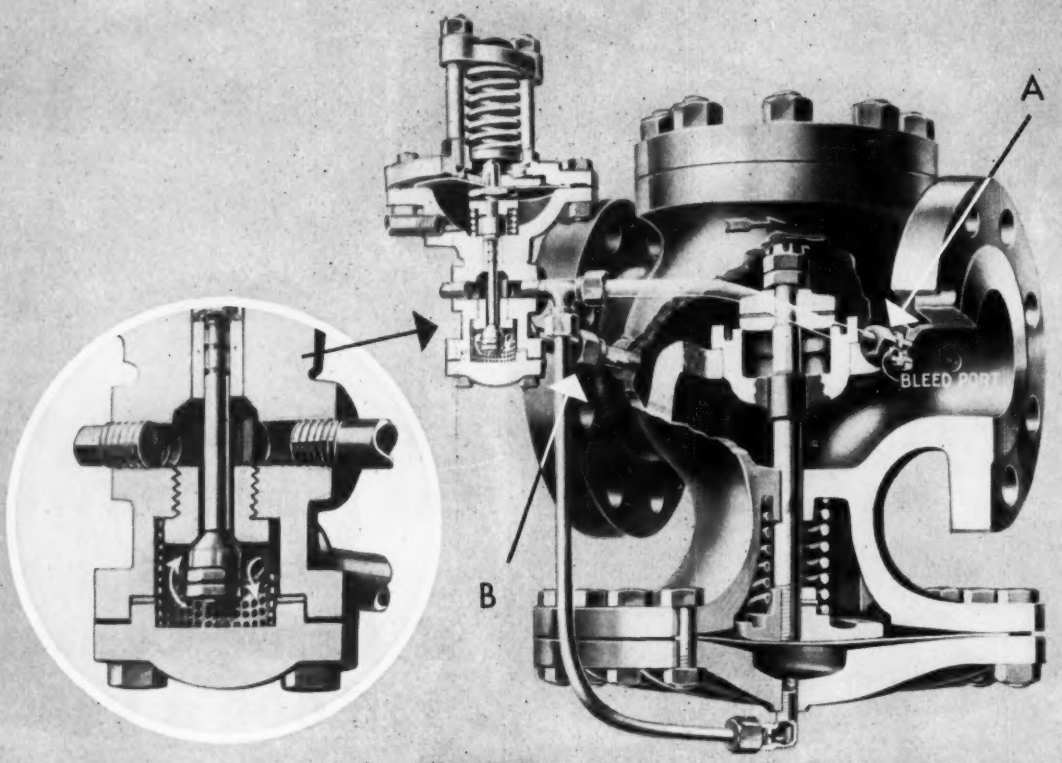
Consult an engineering firm

Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel cost and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems can cut your labor cost to a minimum • Coal is the safest fuel to store and use • No smoke or dust problems when coal is burned with modern equipment • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

Advantages of External Pilots in Automatic Regulating Valves



Spence Type ED Pressure Regulator

"Maintenance-free, trouble-free, install-and-forget." They're all pretty phrases, but every engineer knows from experience they don't apply to regulating valves. Any valve designed to control temperatures or pressures within tight limits can be affected by dirt or other foreign matter in steam lines.

One advantage of the external pilot mounting shown above is simplified maintenance. Trouble shooting is faster, downtime is reduced, and tempers don't take such a beating. Here's why:

If trouble develops, it's easy to find out if it's in the pilot or the main valve. Just remove the tubing bend at A. A simple test, without any instruments or other equipment, shows where the trouble is.

If the trouble is in the pilot, you can remove it by disconnecting the unions at B. There's no need to take the main valve out of the line.

The quickest way to get the regulator functioning again is to install a spare pilot. This is easy — and in the Spence design it's not expensive to carry spare pilots. Spence pilots fit all sizes of Spence main valves. There's no need to stock an expensive inventory of pilots for each main valve size.

In the enlarged sectional drawing above, you can see how the strainer, seat and disc of the pilot are readily accessible by removing the blind flange.

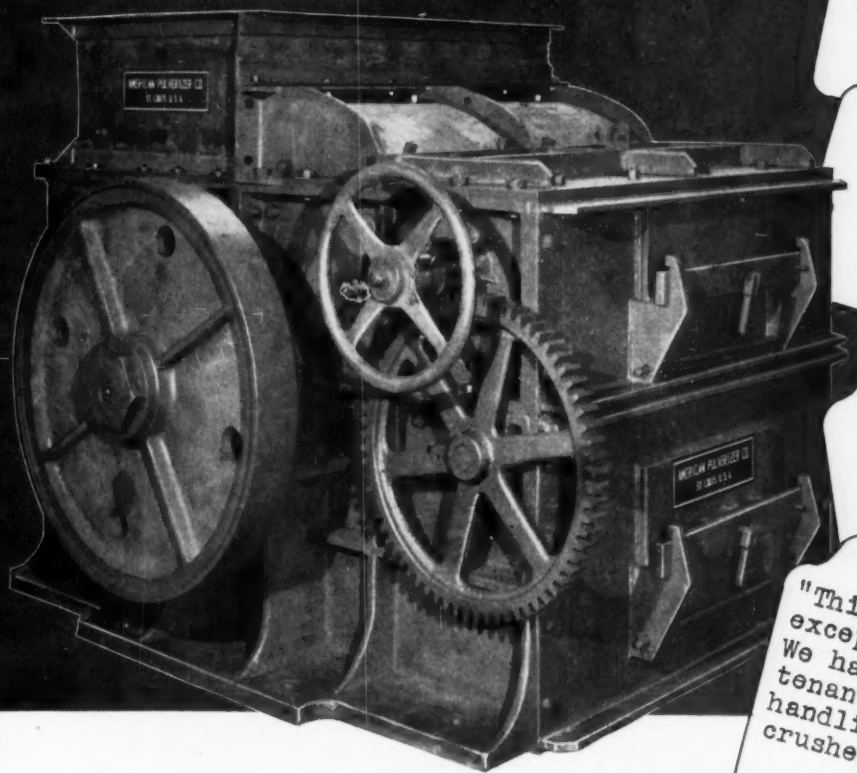
If the trouble is in the main valve, here again inspection is easy. If there's dirt in the steam line, it may clog the bleed port or restriction orifices. In the Spence design these can be inspected and cleaned by merely removing the tubing connections. The seat and disc of the main valve can also be inspected easily by removing the top flange.

These maintenance advantages, plus other advanced design features, are available for a wide range of regulating applications. For information on Spence's wide range of different automatic regulating valves, write for your copy of Bulletin 1005.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

users tell us...

AMERICAN COAL CRUSHERS GIVE GREAT PERFORMANCE AT LOW COST



"This machine has crushed 175,000 tons of coal without replacement parts"

"Has given the least trouble of any machine in our power plant"

"Very dependable piece of equipment"

"A reliable and well applied unit, consistently producing a uniform product"

"This crusher has been giving exceptionally good service. We have had very little maintenance. Does a better job handling wet coal than most crushers"

"We have never done any maintenance work on the crusher. It is still in very good condition with little or no evidence of wear. The repair parts we ordered are being kept in stock for future use"

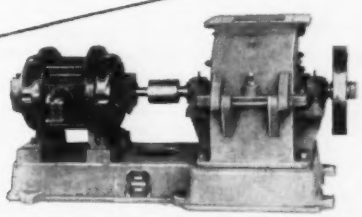
Performances in hundreds of mines, power plants and central stations have proved conclusively that American Coal Crushers can crush coal for *less than 1¢ per ton*, including depreciation, replacement parts, power and interest on original investment.

Write us today indicating your special needs in coal crushing equipment. We'll be glad to give recommendations and cost estimates.

When You Figure Cost Per Ton, the Best Answers Come From American

COAL CRUSHERS
Up to 800 TPH

SAMPLE CRUSHERS
To Suit Your Requirements



FOR LOW-COST COAL-SAMPLE CRUSHING
Model 15 x 9 American Sample Crusher for capacities up to 2000 lbs. per hr.

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1349 MACKLIND AVE. • ST. LOUIS 10, MO.

HOW THIS EMERGENCY LIGHTING UNIT CUTS MAINTENANCE COSTS

LIGHT WARDEN CHARGOMATIC 88

1. Guaranteed *5 years*—both battery and unit.
2. Eliminates manually operated charger switches and timers.
3. Eliminates undercharged and overcharged batteries, cutting maintenance costs to the minimum.
4. Eliminates meters and messy hydrometers.
5. One standard unit can support 5 heads mounted remotely as desired.
6. Needs addition of water only *once* in 6 months.
7. Completely automatic operation assures unfailing protection.

Complete engineering service available. Recommendations and quotations gladly furnished. Catalog on request.

ELECTRIC CORD COMPANY
195-D WILLIAM ST., NEW YORK 7, N. Y.

O-RINGS *are a valve's best friend*

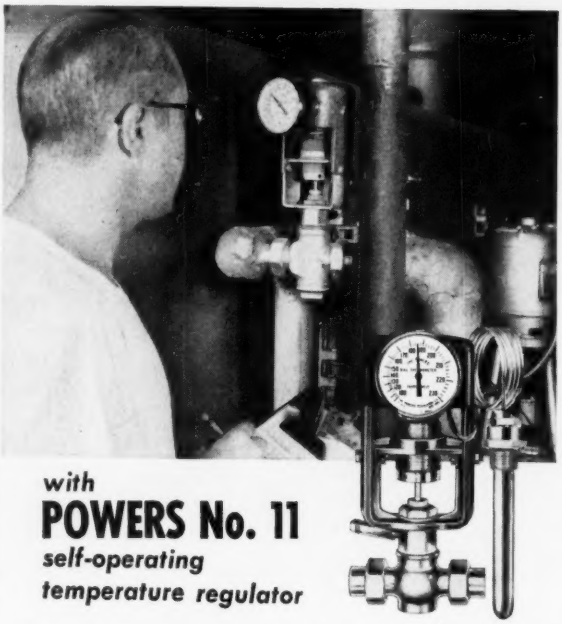
Drippy, leaky valves are just not socially acceptable . . . so, we designed the new Hoke bar stock needle valve with an O-ring stem seal—to give it the right start in life. Result—a seal that will pass a helium leak test . . . no packing adjustments . . . no friction even at high pressure. Self-aligning spindle shuts off tight. For instrument panel, test stand, hydraulic or pneumatic service. In carbon, chrome or stainless steel and brass, for ⅛" to ¼" pipe sizes. Panel mounted, too, if needed.

We've got a brand new wall chart as well as catalog information—Both yours for the asking.

HOKE
HOKE INCORPORATED
Fluid Control Specialists
190 S. DEAN ST., ENGLEWOOD, N. J.

VISIBLE PROOF

of constant temperature control



with
POWERS No. 11
self-operating temperature regulator

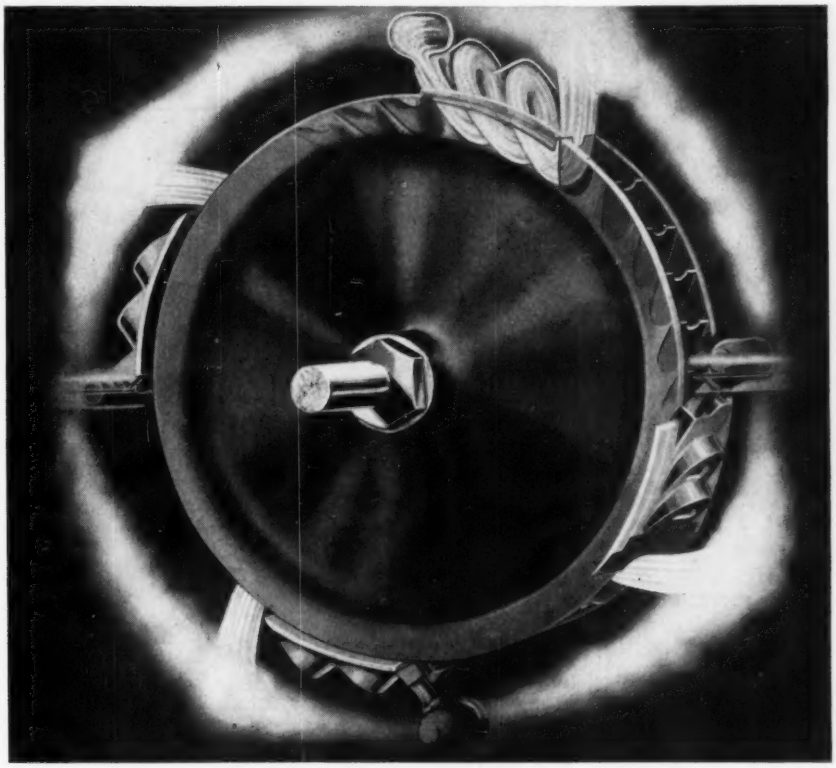
This big four-inch dial gives a quick, visual means of checking controlled temperatures . . . an accurate guide for regulator adjustment.

Designed for precise temperature control, the Powers No. 11 Regulator is self-powered . . . simple, compact and dependable. Full throttling action is gained without the aid of *any* external power source. Special valve stem lubricator eliminates binding. Big double ply metal bellows provide extra valve power — longer life. Union body assures easy installation.

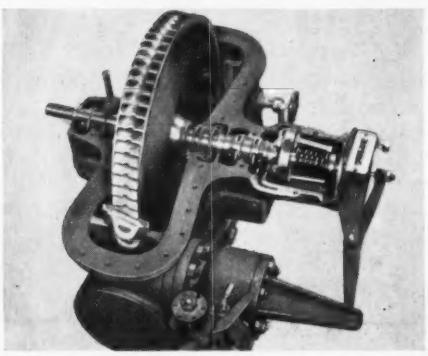
For specifications, valve sizes, types and temperature ranges, call your Powers branch office — engineering services in 66 cities. Write for Bulletins Nos. 329 and 330. ***The Powers Regulator Company, Skokie 24, Illinois***

POWERS
TEMPERATURE CONTROL

TURBINE BLADES CAN'T FOUL!



The Terry solid-wheel turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.



Terry solid-wheel design permits large clearances

In the Terry solid-wheel turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.

The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

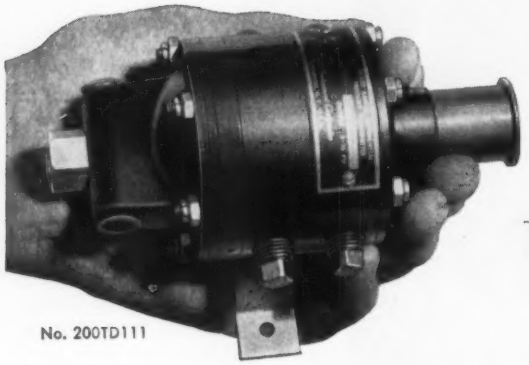
This is only one of the many advantages of Terry solid-wheel turbines. Write for complete details. Ask for a copy of bulletin S-116.

TERRY

TT-1206

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

"That new Taylor Instrument's saving us money already!"



No. 200TD111

He's talking about the new Taylor low-cost Flow Transmitter!

THE reason he can spot the savings so quickly is that the No. 200TD111 Fixed Range Differential Pressure Transmitter is being used to measure departmental consumption of steam, air and water that previously went unchecked. That 3-pen recorder in the background shows at a glance how much is being used by a given department as a basis for apportioning costs. It's the remarkably low price of this new instrument that makes it such a practical cost accounting aid on applications hitherto considered marginal.

Measuring only 6½" x 3" and weighing only 4½ lbs., its simplified piping, force-balance construction and external adjustments make it easy to install and maintain. Calibration accuracy is better than 1%. Sensitivity exceeds 0.1%. Ranges 0 to 50, 100, 200 and 300 inches of water. Built for rough service and outdoor mounting.

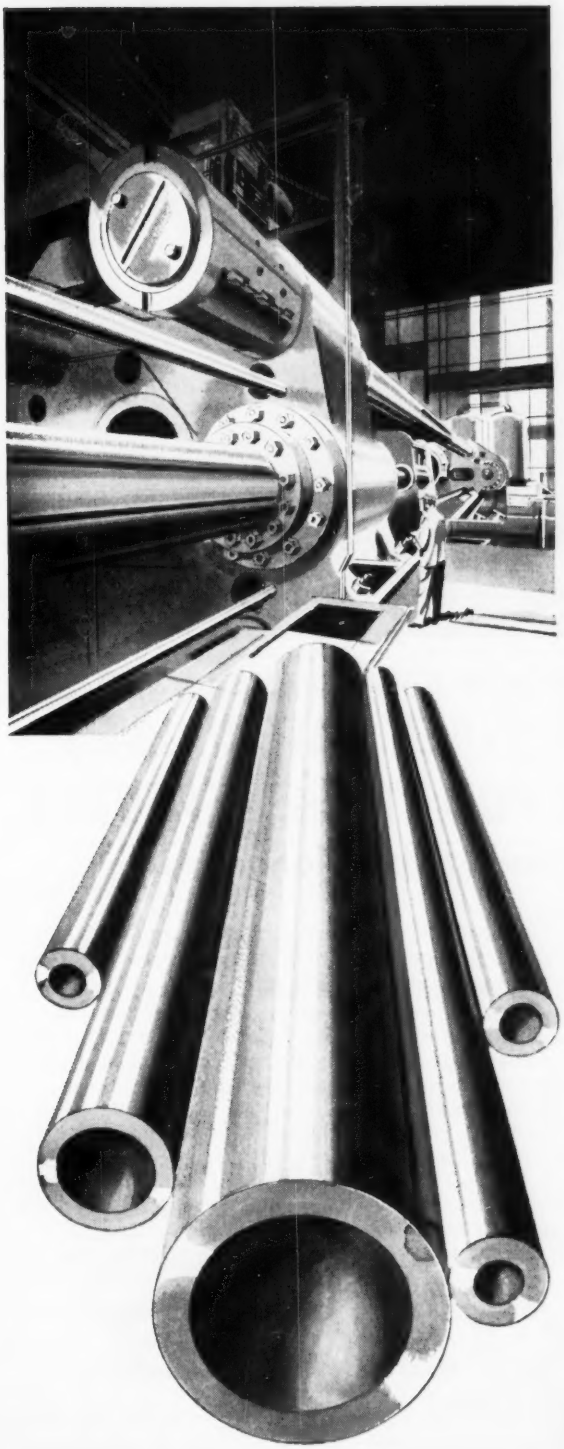
Call your Taylor Field Engineer, or write for **Bulletin 98274.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

DESIGN SPECIFICATIONS

Diaphragm of Neoprene-impregnated Nylon.
Body material, brass.
Maximum working pressure: 150 psi.; temperature 150°F.
Air Supply pressure, 20 psi.
Air consumption, 0.10 standard cu. ft. per minute.
Output pressure range 3 to 15 psi.
Size 6½" x 3". Weight 4 lbs. 9 ozs.
All connections ¼" internal NPT.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

NOW! from the world's largest horizontal steel extrusion press...



SEAMLESS

HEAVY WALL PIPE

from any ferrous alloy

Now heavy wall pipe can be extruded from any ferrous alloy – in lengths up to 50 feet or more, with O.D.'s from 4″ to 22″, and with virtually no restriction on wall thickness.

The giant Curtiss-Wright horizontal extrusion press, now operating at the Metals Processing Division, *moves* the metal instead of *removing* it, for pipe of maximum length – and strength.

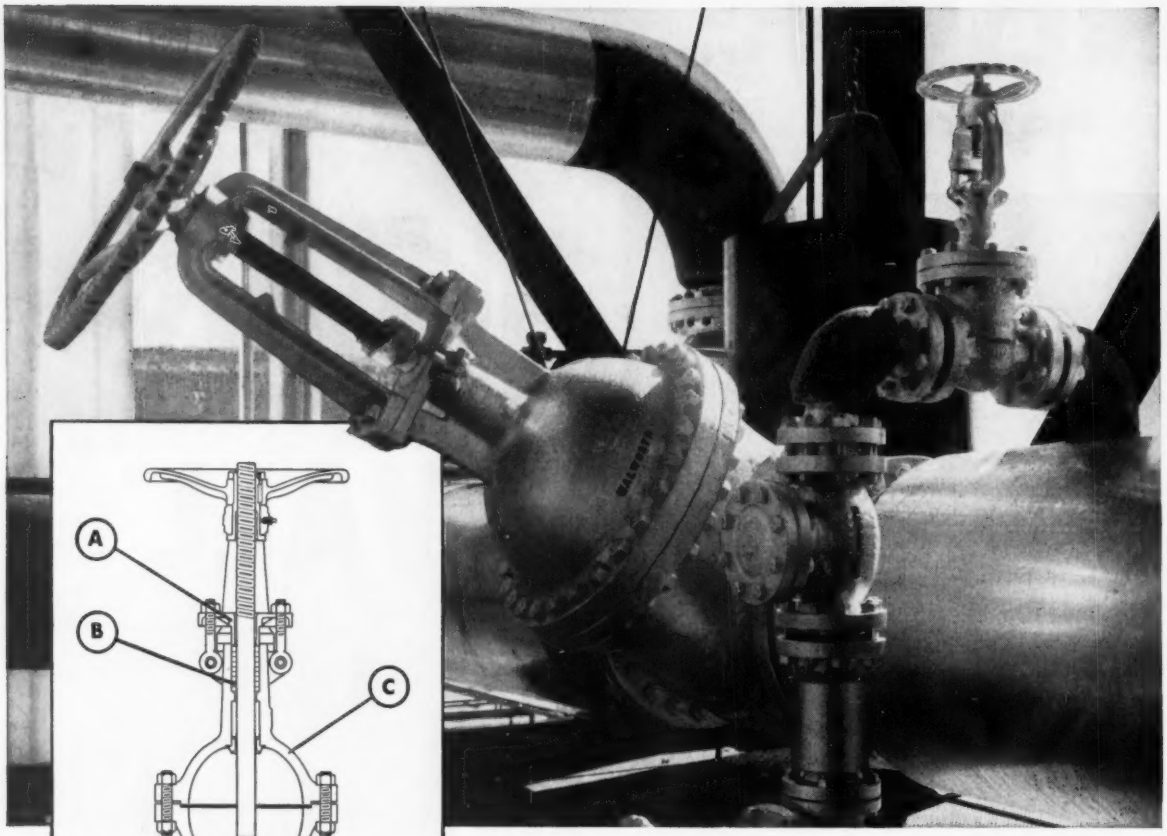
If your application calls for higher heat, corrosion and/or abrasion resistance – in pipe of highest tensile and yield strengths – Metals Processing Division is geared to fill the requirement. Complete facilities for handling any ferrous alloy, including the stainless series, as well as titanium and other reactive metals, are available to the chemical, petroleum, power and other key industries.

Take advantage of this new, aggressive facility for your pipe requirements. Write, wire or telephone for detailed information or engineering consultation today. Our field engineers are at your service.

88 GRIDER STREET

METALS PROCESSING DIVISION

CURTISS-WRIGHT CORPORATION • BUFFALO, NEW YORK



Walworth Series 150 and 300

CAST STEEL GATE VALVES OFFER YOU THESE FEATURES

for 'round-the-plant service

(A) GLANDS: Clearances between the gland and stuffing box, and gland and stem, are such that the stem cannot be scored even if the gland is pulled down unevenly.

(B) DEEP STUFFING BOXES: More than adequate in all sizes (2″ to 24″) to assure tightness and maximum packing life.

(C) BONNETS AND BODIES: Engineered to exceed the requirements of all applicable codes and standards. They are tough, durable, dependable.

(D) INTEGRAL GUIDE RIB FACES IN BODY: Machined to insure accurate centering of the gate.

(E) STURDY SEAT RINGS: Bottom-seated so that no recess exists at the back of the ring to cause turbulence, erosion and pressure drop.

(F) STREAMLINED PORTS: Permit unobstructed flow which results in minimum pressure drop and reduces the possibility of erosion.

Walworth Cast Steel Gate Valves can be furnished with either flanged ends or butt welding ends. Roller bearing yokes are available on the larger sizes. On valves 4 inches and larger, by-passes can be furnished. Walworth Cast Steel Gate, Globe and Check Valves from Series 150 to 2500, are available. For Series 600 and higher, we recommend Walworth Pressure Seal Cast Steel Valves. See your Walworth Distributor or write to Walworth for complete information.

WALWORTH

60 East 42nd Street, New York 17, New York

SUBSIDIARIES: ALOYCO ALLOY STEEL PRODUCTS CO. CONOFLOW CORPORATION M&H VALVE & FITTINGS CO. SW SOUTHWEST FABRICATING & WELDING CO., INC. WALWORTH COMPANY OF CANADA, LTD.

WHERE TO BUY

Featuring additional products specialties and services for power plants

STEEL PIPE & TUBING

• CHROME MOLY • CARBON MOLY
• CARBON STEEL • STAINLESS

Widest Range of Sizes & Specs in the U. S.
WRITE FOR STOCK LIST
MIDCONTINENT TUBE SERVICE, INC.
2306 Oakton St., Evanston, Ill. DA 8-4030

TO STEAM PLANT OPERATING MEN

Are you interested in a Correspondence Course in the PRACTICAL OPERATION of an atomic energy power plant? Full details sent on request without obligation.

STEINER TECHNICAL WRITINGS
7503 Seven Mile Lane Baltimore 8, Md.

This WHERE TO BUY section is a special classification for manufacturers desiring advertising in space units smaller than the minimum run of book display space. Space is available in this section in units from one to four inches. Each advertisement is indexed. For low rates write: Classified Advertising Division.
POWER, 330 West 42nd St., New York 36, N. Y.

PROFESSIONAL SERVICES

BLACK & VEATCH
Consulting Engineers
Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction, Investigations, Valuation and Rates
1500 Meadow Lane Pkwy, Kansas City 14, Missouri

BURNS & McDONNELL
Engineers—Architects—Consultants
Kansas City, Mo. Phone
P. O. Box 7088 DElmar 3-4375

NO TIME TO EXPERIMENT . . .

So why not save time by calling in a specialist who knows the ground you are exploring.

POWER, meeting place of power men in all parts of the country, points the way to the solution of many power problems through its Professional Service Section.

SEELYE STEVENSON VALUE & KNECHT
Consulting Engineers
Mechanical—Electrical—Civil
Surveys Reports Design
101 Park Avenue New York 17, N. Y.

J. E. SIRRINE COMPANY
Engineers
Power Plant Consultations
Design Reports
Water Steam Utilization Plants
Greenville South Carolina

GILBERT ASSOCIATES, INC.
Engineers and Consultants
Design and Construction Supervision
Mechanical • Electrical • Structural
Sanitary • Chemical Laboratory
Business and Economic Research
New York Reading, Pa. Washington

LUTZ AND MAY COMPANY
Consulting Engineers
Steam, Gas & Diesel Power Station
Pumping Plants—Electric Systems
Reports—Design—Appraisals
1009 Baltimore Kansas City 6, Mo.

STANLEY ENGINEERING COMPANY
Consulting Engineers
327 S. La Salle Street Hershey Building
Chicago 4, Illinois Muscatine, Iowa

INTERNATIONAL ENGINEERING COMPANY, INC.
Engineers
Investigations — Reports — Design
Procurement — Field Engineering
Domestic and Foreign
74 New Montgomery St., San Francisco 5, Calif.

PIONEER SERVICE & ENGINEERING CO.
Consulting and Design Engineers
Purchasing
Specialists in
Financing, Accounting & Other Operations
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Consulting Engineers
Industrial and Process
Forest Products Industries
Power Plants
Reports, Specifications, Designs, Supervision
2210 West 12th Ave., Vancouver 9, B.C. CEdar 1154

THE KULJIAN CORPORATION
Engineers - Constructors - Consultants
POWER PLANT SPECIALISTS
(Steam, Hydro, Diesel)
Utility • Industrial • Chemical
1200 N. Broad St. Philadelphia 21, Pa.

FRANK C. REYNOLDS
Registered Consulting Engineer
Surveys, Reports, design and construction supervision of air conditioning, heating, ventilating, oil and gas burners & control systems.
136 Liberty St. New York 6, N. Y.

TIPPETT & GEE CONSULTING ENGINEERS
Mechanical—Electrical—Thermodynamic—Structural
Design—Studies—Supervision
Power Stations—Transmission—Distribution
Industrial Plants—Process
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PETER F. LOFTUS CORPORATION
Design and Consulting Engineers
Electrical • Mechanical • Structural
Civil • Thermodynamic • Architectural
First National Bank Building
Pittsburgh 22, Pennsylvania

SANDERSON & PORTER ENGINEERS
Design
Construction
New York New York

WATER SERVICE LABORATORIES, INC.
Specialists in Water Treatment for Corrosion Prevention
Main Office:
423 W. 126 St. New York 27, N. Y.

THE LUMMUS COMPANY
Engineers and Constructors
385 Madison Ave., New York, N. Y.
Chicago . . Houston . . London
Paris . . The Hague . . Montreal
Caracas . . Bombay

SARGENT & LUNDY
Engineers
140 South Dearborn St. Chicago, Illinois

THE J. G. WHITE ENGINEERING CORPORATION
Design-Construction-Reports-Appraisals
80 Broad Street, New York 4

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant
Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

DISPLAYED —RATES— **UNDISPLAYED**

The advertising rate is $25.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$1.65 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—count as 1 line

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS or Inquiries to Classified Adv. of Div. of Power, P. O. Box 12, New York 36, N. Y. for March issue closing February 8th

PLUS FACTOR

The Ohio Valley Electric Corporation, a new electric utility located in Southern Ohio, has immediate openings for

GRADUATE ELECTRICAL ENGINEERS

These openings will appeal to men who know or want to learn about Relays, Meters, Communications, Transmission and Test.

OUR COMPANY OFFERS

- **Good Salaries** + **Substantial financial assistance for further education**
- **Good Benefits** + **Opportunities for advancement**
- ***Employment Security*** + **Experience in 330-KV transmission**

OUR COMMUNITY OFFERS

Good inexpensive rental or purchase housing
+
Excellent recreational facilities
+
New uncrowded schools
+
A good place to raise a family

IT ADDS UP TO A GOOD OPPORTUNITY

SEND BRIEF RESUME TO:

OHIO VALLEY ELECTRIC CORP.

ATTN: Personnel Director **P.O. Box 468**
Chillicothe, Ohio

PROJECT ENGINEER

Our firm, a large engineering construction contractor, has a staff position for a qualified Mechanical Engineer with experience in building steam power plants.

The successful applicant will take complete charge of a job as Project Engineer supervising the layout and design and selecting of plant equipment.

Please furnish to our Personnel Manager a complete resume of your experience, education, references and salary requirements. Also enclose a snapshot if available. One of our many benefits is a Profit Sharing and Retirement Plan.

J. F. PRITCHARD & COMPANY
4625 Roanoke Parkway, Kansas City 12, Missouri

REPLIES (Box No.): Address to office nearest you
c/o this publication Classified Adv. Div.
NEW YORK: P. O. Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

Wanted — Young Engineer for sales position, Philadelphia Area, handling steam specialties, steam turbines, controls. Excellent permanent opportunity for right man. Write to P-3845, Power.

Assistant Load Dispatcher—Pasadena, Calif. Salary $399-486. Six years experience desirable in the operation of power plants or major utility sub-stations. Will assist in dispatching on a system consisting of 2 steam plants and related receiving & sub-stations. Apply Rm. 200, City Hall.

Relay Tester—Pasadena, Calif. Salary $441 to $537 depending on experience. Desired—2 years college; advanced courses in principles of electricity with 5 years experience in the installation, maintenance, and testing of power plant and sub-station instruments. Apply Rm. 200, City Hall.

SELLING OPPORTUNITIES OFFERED

Manufacturer's Representatives and Distributors —wanted to handle sales and service of miniature (¼ H.P. up to 5 H.P.) electric steam generators up to 100 lbs. pressure—each unit bearing a Registered National Board of Boiler and P. V. I. Number, individually inspected under the miniature boiler code. We have specialized in this field for 10 years and desire only men who know and work with steam, or equipment requiring steam for its operation. Please reply Box RW-3535, Power.

Water conditioning equipment manufacturer desires agents for New England and Upstate New York area. RW-3789, Power.

SELLING OPPORTUNITIES WANTED

Established sales representative (three men), metropolitan New York City area desires additional line, preferably for industrial and, or, utility boilers. RA-2590, Power.

Sales engineer desires line of chemical solution proportioning pumps for metropolitan New York. SA-3510, Power.

POSITIONS WANTED

Chief Engineer, age 35, married, technical education, 12 years experience in all phases of operation and maintenance of steam electric power plants. PW-3783, Power.

Engineer—age 35, Technical education, experience in supervision, design, installation, operation and maint. 12 years in utility and industrial plants. Four in public owned utility. Desire change, will relocate, within reason. Desire supervisory position. PW-3926, Power.

An employment advertisement in this EMPLOYMENT OPPORTUNITIES section will help you find the engineers you need. It's an inexpensive, time saving method of selecting competent personnel for every engineering job.

FOR RATES OR INFORMATION

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WAlnut 5778
M. MILLER

BOSTON, 16
350 Park Square
HUbbard 2-7160
H. J. SWEGER

CHICAGO, 11
520 No. Michigan Ave.
MOhawk 4-5800
W. HIGGENS — J. BRENNAN

CINCINNATI, 37
1825 Yorktown Rd.
Swifton Village, Apt. 2
REdwood 1-3238
G. MILLER

CLEVELAND, 15
1510 Hanna Bldg.
SUperior 1-7000
W. SULLIVAN

DALLAS, 2
Adolphus Tower Bldg., Main & Akard Sts.
RIverside 7-5064
G. JONES

DETROIT, 26
856 Penobscot Bldg.
WOodward 2-1793
W. STONE

LOS ANGELES, 17
1111 Wilshire Blvd.
MAdison 6-4323
H. L. KEELER D. McMILLAN

NEW YORK, 36
330 West 42 St.
LOngacre 4-3000
S. HENRY D. COSTER
R. LAWLESS R. HATHAWAY

PHILADELPHIA, 3
17th & Sansom St.
RIttenhouse 6-0670
H. BOZARTH

ST. LOUIS, 8
3615 Olive St.
JEfferson 5-4867
W. HIGGENS

SAN FRANCISCO, 4
68 Post St.
DOuglas 2-4600
R. C. ALCORN

Electrical Engineers Designers

BECHTEL

Offers you immediate long range engineering opportunity in

San Francisco
or
Los Angeles, Calif.

Engineers, designers and draftsmen required with the following experience:

Electrical Sub-Station
Hydro-Electric Power Plants
Steam Electric Generating Station

Liberal relocation allowances for you and your family.

Send Resume to
Manager of Employment & Placement
Industrial Relations Division

BECHTEL
CORPORATION
220 Bush Street
San Francisco 4, Calif.

For an immediate personal interview you may phone: Paul Keating, MUrray Hill 7-7100, New York City Joe Braddick, Fairfax 3-2401, Houston, Texas Bill Milliagn, Tucker 1549, Los Angeles, Calif. Don Palmer, Douglas 2-4032, San Francisco, Calif.

LESS THAN HALF A DAY FROM THE U.S.A.

Attractive position available with STANDARD OIL COMPANY (NJ) affiliate in the Caribbean area

ELECTRICAL INSTRUCTOR

Will supervise instruction of apprentices, prepare training materials, training schedules and conduct "on-the-job" instruction in a large, modern refinery.

Applicants should have high school education and minimum of 5 years experience as artisan, instructor or supervisor in electrical trade.

WRITE

Giving complete address, age, marital status, education and details of previous experience—

BOX 308-V
RADIO CITY STATION
NEW YORK 19, NEW YORK

DESIGNERS

4 MAJOR JOB ADVANTAGES

now offered by
DU PONT

•

Interesting, challenging, professional work assignments.

•

Long-range company programs assuring stability.

•

Promotion-from-within policy assuring opportunities for advancement.

•

Varied technical and administrative training programs.

•

IMMEDIATE OPENINGS FOR:

Power Designers
Heating & Ventilating Designers

Apply today for a position that will allow you to realize your full potential as a designer. Your work will be in a wide range of increasingly important fields.

Please send complete resume, including details of education and experience, to:

Mr. T. J. Donovan
Engineering Department

DU PONT

Better Things for Better Living
...through Chemistry

E. I. du Pont de Nemours & Co., Inc.
Wilmington 98, Delaware

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

UNDISPLAYED RATE:

$1.65 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS $1.65 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED RATE:

The advertising rate is $17.90 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

Send NEW ADVERTISEMENTS or Inquiries to Classified Advertising Div. of Power, P. O. Box 12, N. Y. 36, N. Y. for March issue closing February 8th

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R U safe? Leading power men rate

STEAM KNOTTY ERRORS

by a veteran examiner for issuing licenses the most practical work in this field. Many say-'There's more in that little book than in all my others.' An editor-'masterpiece.' A supt.-'It saved us thousands of dollars.' Also-'Why don't they tell us those things?' All hands have sadly neglected basic facts herein explained for clear, safer judgment.

You'll enjoy it. 4th Ed. Send $2.00 to

The STEPLER Co. 1514 35th Ave. Seattle 22, Wash.

TRANSFORMERS

2—2000 Kva GE 13200-2400 Scott Tap
3—1667 Kva GE 13800-600
3—1000 Kva GE 13800-460
15— 50 Kva GE 33000-2400 New
120— 25 Kva GE 33000-2400 New

MOTORS • GENERATORS
TRANSFORMERS • SALES
REPAIRS • RENTALS

AMERICAN ELECTRIC SERVICE & MAINTENANCE CO.
Paramount & 2nd Sts., Springfield, Mass.
REpublic 2-2104; 2-2105

LATE PACKAGE BOILERS

Less than five years old. Pressures 160 to 250 p.s.i. 10,000 to 25,000 lbs. per hr. rating. Currently in use. Released in 60 days.

Also Steam Turbine Generators, Diesels—Transformers—Switchgear, etc.

HOWE BROS.
342 Madison Ave., New York 17, N.Y.
Telephone: MUrray Hill 2-8562

ATTENTION ENGINEERS
Reprinting Kents 11th Edition (Power) $16.00.

This book is necessary for examinations in Steam Boilers, Engines, Pumps, Fittings, Geometry, Refrigeration, Logarithms.

A. LeCLAIR
7543 St. Denis St., Montreal, Que., Canada

New and Used Equipment Available for
POWER PLANTS, SUBSTATIONS, TRANSMISSION LINES AND CONSTRUCTION
Send for new list
EBASCO SERVICES INCORPORATED
APPARATUS EXCHANGE — Two Rector St., New York 6, N. Y.

GET 2nd ENGINEER PAPERS IN 1 YEAR

(Yes, get better stationary engineers License!)

No correspondence school bother. Nationally-known Chief Stationary Engineer Frederick C. Walker's 100-Question, 100-Answer Bulletins give you the straight dope quick. Send $3 to Walker & Collins, 524 Ashland Ave., Buffalo 22, N. Y. for first set today. Keep working. Save year.

CASH FOR SURPLUS NEW MOTORS

Ajax pays hard cash for your new surplus motors, controls and transformers. Send your list of new surplus equipment today. It means cash for you.

NEW MOTORS AVAILABLE
We have over 5,000 new motors—IN STOCK—from ¼ HP to 200 HP. Save Money.

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AJAX ELECTRIC MOTOR CORP.
P.O. Box 262 • Rochester, N.Y.
Long Distance Phone LD. 132

BOILERS

Hodge-Scotch-Marine—250 H.P. 125 lb. #6 Oil.
Titusville Scotch Marine—150 H.P. 15 lb. #6 Oil.
Package Pf'd. Utilities—300 H.P. 100 lb. #6 Oil.
Package Water Tube—125 H.P. 125 lb. #6 Oil.
Leffell Scotch Marine—100 H.P. 125 lb. #6 Oil.
York-Shipley Package—30 H.P. 15 lb. #2 Oil.

JOSEPH KRAUSS, INC., PO Box 95, Ramsey, NJ

FOR SALE — Immediate Delivery

Two 78" Dia. by 20 ft. 200 HP ERIE H&T BOILERS. 150 PSI Supporting steel—ASME NAT BD Stamp Mfg. 1928. A1 Condition. Can load truck or rail.

PAUL RUDBECK
RR4 Box 11, South Bend 28, Indiana

2600 KW DIESEL POWER PLANT

Four each General Motors 12-567A Diesels, 1080 BHP, 720 RPM direct connected to 937.5 KVA, 659 KW Electric Machinery Manufacturing Company alternating current generators, 3 phase, 60 cycle, 480 volts.

These units being offered complete with all control and auxiliary equipment. Now in operation and may be inspected at any time. Will be available in April. Will sell separately.
BIDS INVITED

WAH CHANG MINING CORP.
137 Clarke St., Bishop, Calif. Ph. 8911

WANTED

Steam Engine Generator Sets • Turbines • Condensers • Generators • Boilers or Complete Power plants.

PAUL OBERMAN
1910 Delmar — St. Louis, Mo.

FOR SALE
1 STRONG-SCOTT PULVERIZER

Size B12-LH, equipped with a B8 blower. Serial #51123, S.O. 613036 with extra parts.

GLOVERSVILLE KNITTING CO.
Gloversville, New York

WORLD'S LARGEST INVENTORY

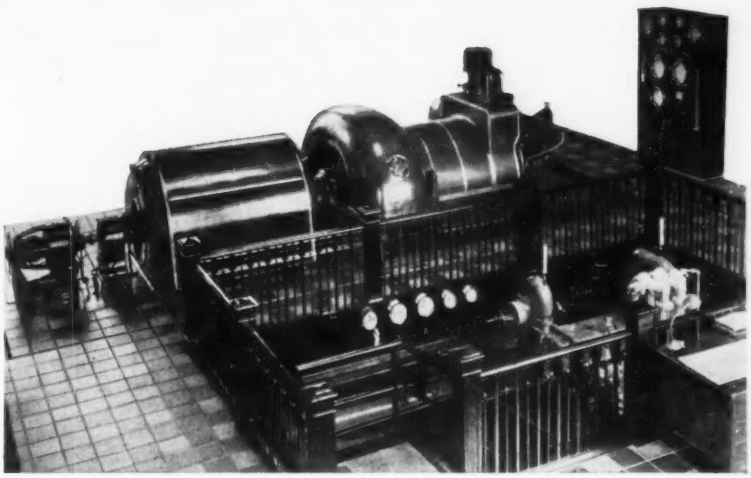
NEW AND GUARANTEED REBUILT EQUIPMENT

WRITE, WIRE OR PHONE

ELECTRIC EQUIPMENT CO.
L. D. (Long Distance) 65
ROCHESTER 1, NEW YORK

6—3500-KW 250/350 V MG Sets

MODERN 400 LB., 750 DEG. TURBINE-GENERATOR:



The above G.E. 3750 KVA, 400#, 750 Deg. F. unit in excellent condition, complete. Generator 3/60/2300/4160 V. ***We also have in stock:*** 3750 KVA, 440# PSIG, 750 Deg. FTT, 3/60/2300/4160 V., Condensing. 3125 KVA, 250/300# PSIG, (good for 400# with changes), 750 Deg. F. Automatic Extraction 50#, Condensing, 3/60/13,800 V.

CHARLES WEAVER

19701 James Couzens Hwy. **Tel: BRoadway 3-1901** **Detroit 35, Michigan**

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450 HP TO 750 HP
GAS ENGINES
LOT OF ALLISON ENGINES—
MODEL V-1710 12 CYLINDER
ALL IN EXCELLENT CONDITION
SOME NEVER USED
Can be operated on Natural Gas, Butane, Gasoline, etc.
IMMEDIATE DELIVERY
PERRY EQUIPMENT CORP.
1422 N. Sixth Street
ST 4-3505 **Phila. 22, Pa.**

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3 NEW BOILERS

Available at fraction of new cost

BABCOCK & WILCOX single uptake controlled superheat marine type express boilers, 3 drums, with economizers.

Designed pressure	634 lbs.	Steam temperature	850°F
Operating pressure	550 lbs.	Furnace volume	1473 cu. ft.
Superheated steam	221,000 lbs./hr.	Total generating surface	9338 sq. ft.
Saturated steam	32,000 lbs./hr.	Superheater surface	1620 sq. ft.
Full power total	253,000 lbs./hr.	Economizer surface	3843 sq. ft.

NOTE: These boilers are new and complete. They are erected and ready for use and should therefore be considered only for such places as can be reached by water transportation.

HUGO NEU CORPORATION

45 Nassau St. **Tel: REctor 2-1334** **New York 5, N. Y.**

BOILERS

HI-PRESSURE
Complete stock from 10-2,000 h.p.
Nation's largest inventory. New & Used.
WABASH POWER EQUIPMENT
31 E. CONGRESS, CHICAGO 5, HA 7-4855

FOR SALE

5—OIL CIRCUIT BREAKERS

Whse. late type, outdoor type, De-Ion Grid, T.P.S.T., Rated 161000 V., 1200 amps., 60 cy., 3 ph., Type GO-3, Interr. Duty 1,500,000 KVA.

Fully complete—Cond. like new.

Price and further inf. upon request.

PHILADELPHIA TRANSFORMER CO.
Box 566 **Dalton, Pa**

SPECIAL OFFERINGS

2—6000 CFM Ingersoll-Rand Type XHE—28 PSI size 31½ x 31½ x 14 Horz. Duplex, 600 HP, 300 RPM, 3 phase, 60 cycle, 4160 Volt, Unity P.F. complete with control panels—LATE—Condition excellent—immediate shipment.

2—New 200 HP Titusville—Iron Fireman Scotch Boiler—Burner Units, Heavy Oil Automatic 150 lb.

THE O'BRIEN MACHINERY CO.
ESTABLISHED 1915

1916 W. CLEARFIELD ST. **PHILADELPHIA 32, PA.**
Frank L. O'Brien, Jr., *President & Treasurer*

BELYEA RE-NU-BILT

LARGE ELEC. POWER EQUIPMENT
SELECTED STOCK ITEMS

RE-NU-BILT—GUARANTEED—RE-NU-BILT
COMBINATION MILL DRIVES — 15/2500 HP
D.C. MOTORS WITH M.G. SETS & CONTROLS

Qu.		MAKE	TYPE	VOLTS	R.P.M.
1—2200	HP	G.E.	MCF-12	600	400/500
22001	KW	G.E.	Syn	2300/4600	514
1—1250	HP	G.E.	MCF	600	600/750
1000	KW	G.E.	Syn.	2300/4600	720
1—1000	HP	G.E.	MCF-8	600	350/700
1000	KW	G.E.	Syn.	2300/4160	720
1— 225		Whse.	SK-185	375	950/1200
1— 200	KW	Whse.	Sq. Cage	440	1200

ALSO MANY OTHER COMBINATIONS

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
2	1750	G.E.	M-579BS	4800/2400	1800
1	1500	G.E.	MT	6600	257
1	1500	G.E.	MT	6900	1187
1	1100	F.M.BB	SF806S	4800/2400	1800
1	1000	A.C.	Mill	2300	240
1	800	G.E.	MT	2300	293
1	750	G.E.	MT-573	2200	1190
1	700	Al. Ch.	D.P.	2300	500
1	500	Whse.	CW	550	350
1	400	Whse.	CW	440	514
1	250	Cr. Wh.	8IZE-290	2300	350
1	350	G.E.	IM-17A	440/2200	720
1	250	G.E.	MT-424Y	4000	257
1	250	A.C.		550	600
1	200	G.E.	IM	2200	580
1	200	G.E	MT-557Y	220	1760
1	150	Whse.	CW30E17	2300	435
2	125	A.C.	ANY	440	865

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
1	650	G.E.	PT-559BY	440	3570
2	450	Whse.	CS-1420	2300/4150	354
1	400	G.E.	1K	2200	500
1	300	G.E.	KT-559A	2300	1775
1	200	G.E.	1K-17	440	580
3	200	G.E.	KT-557	440	1800
1	150	Whse.	CS	440	580

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	4350	C.W.	3501-SL	13800/6900	514
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900
2	2000	Whse.		2300	120
1	1100	G.E.	ATI	2300/4600	900
2	350	G.E.	TS	2200	150

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
3	2000/2400	G.E.	450	250/300	2300/4600
1	2000	G.E.	500-25cg	660	11000
2	2000	G.E.	514	600	4800/2300
1	1750/2100	G.E.	514	250/300	4800/2400
1	1500	G.E.	720	600	6600/13200
1	1500	G.E.	514	250	2300/4600
1	1000	G.E.	900	260	6600
3	1000	G.E.	720	600	6600/13200
1	750	G.E.	720	275	6600/13200
1	750	G.E.	720	125/250	2300/4600
1	500	Whse.	900	125/250	440
3	300	G.E.	1200	250	2300
1	150	Whse.	1200	275	2300

WELDING M.G. SET

Gen. Elec.—1100 Kva 0.7 p.f.—2300/4600 V. 3/60
Generator with 1750 Kva—.8 p.f.—2300 V. 3/60
motor complete with exciter set and controls.

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltage
1	3000	A. C.	OISC	3	33000x2400/4160
1	2500	Al. Ch.	OISC	3	34500x13800
3	1000	G.E.	OISC	1	13800x230/460
2	750	G.E.	Fur	1	4800x85/55
3	500	G.E.	HD	1	4800/2400/480
3	500	Kuhl	OISC	1	13800x6900
3	333	G.E.	H	1	6900x230/460
3	250	I.M.	OISC	1	14400/13800/240/120
3	200	G.E.	H-KS	1	2400/4160YK120/240

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
1	5000	G.E.	60/50/60	6600/11000/6600
2	2500	G.E.	25/62.5	2300/2300
1	1000	G.E.	25/58.3	4400/2300
1	500	Al. Ch.	25/60	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G.E.	Condensing 425 — 750 F.T.T. Surface Condenser 3/60/2300/4000 V Direct con exciter.
1	1500	Whse.	Auto extraction 190 lbs. — 660° F.T.T. 60 lb. extraction 3/60/240 V. Div Conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175200# U.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300. Non-condensing 175/200 lbs. I.S.P. 5/20 lbs. G.B.P., 430/3/60.

BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.

Rebuilt HEMPHILL Guaranteed EQUIPMENT

TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
2	750	G.E.	H	1	4600-120/240
1	750	G.E.	HT	3	4150Y-220/440
2	250	G.E.	H Pyranol	1	2400-4800/8320Y-120/240
2	250	West.		1	2300/4600-230/460
3	200	G.E.	H-KD	1	13800/12420/4600-240/480
3	200	G.E.	H	1	7800/15600-220/440
1	150	Eisler	OA	1	4160-240/480
3	150	West.	S	1	2400/4160-460/230/115
3	100	Niagara	Air Cld	1	2300-120/240
3	50	G.E.	HS	1	2400/4160-240/480
2	37½	West.	Hypersil	1	2400/4160-240/480
6	15	Maloney	KL	1	2400/4160Y-120/240
1	1500	Maloney	ASPI, Askrel	3	2400/4160-480 Power Center.

SYNCHRONOUS MOTORS

Qu	HP	Make	Speed	Type	Volts
1	100	G.E.	900	TS	2300
1	125	G.E.	600	TS	2300
1	125	E.M.	900		4800
1	150	G.E.	1800	TS	220/440
2	150	Allis-Ch.	360		2200
1	150	West.	900		220
1	300	E.M.	720	TEFC	2300
1	500	West.	450	HR	440
1	1000	West.	360	Mill	2300/4150

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
1	15	G.E.	900	MT-542	440
1	25	G.E.	900	MT-526	440
1	60	G.E.	1800	MT	220
1	60	Ideal	900	AV	220
1	75	G.E.	600	IM	440
3	150	Allis-Ch.	1800	AT RW	2300
1	200	West.	514	CW	440
1	250	West.	600	CW	440
1	350	West.	1800	CW	2300
1	500	G.E.	1200	M	2400/4150

SQUIRREL CAGE

Qu	HP	Make	Speed	Type	Volts
1	40	Wagner	1750	CP TEFC	220/440
1	25	G.E.	1170	405TEFC	220/440
1	75	G.E.	1800	K-445S	440
1	100	Cont.	3550	N504X	440
1	100	West.	1160	CS	440
1	150	G.E.	720	KT-562	440
2	250	G.E.	1790	K.-T.E.F.C.	2300
1	275	G.E.	1200	KT559BS	2200
2	300	G.E.	1800	K-4150Y	new
1	400	Cont.	1200	N806S	2300

MOTOR GENERATOR SETS

Qu	K.W.	Make	Speed	Volts DC	AC
1	30	G.E.	1800	125	220/440 V.
3	60	E.M.	1200	125	220 v. Syn.
1	150	Cr. Wh.	600	125	220/440
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y S.R.
1	1000	West.	720	600	2300/4160Y

D.C. 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
1	75	C.W.	900	WP
1	125	G.E.	1790	RC
2	150	C.W.	900	WP
1	250	Allis Ch.	1750	FBL149BB

A.C. HOIST MOTORS

Qu	HP	Make	Type	Speed	Volts
1	35	G.E.	MTC	565	440
2	300	G.E.	ITC-5017	600	440

"FOR POWER"
J.L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK LONGACRE 5-3227
PHONE NEW JERSEY UNION 3-2200

POWER PLANT EQUIPMENT

SPECIAL OFFERINGS

TURBO-GENERATORS

1—1000 KW—240 volts—130/250# Condensing Auto. Extraction—15#—New 1945
1—1000 KW 480 volts—225# Condensing Auto. Extraction—20#
1— 400 KW—550 volts—400# Condensing Auto. Extraction—20/50# New 1948
1— 300 KW—480 volts—210# Condensing Auto. Extraction—40#
1— 250 KW—240 volts—130#—Non-Cond. 10/12# Back pressure

TRANSFORMERS

1—500 KVA 4160/480 V. Pyranol. 3 ph.
3—500 KVA 2300/550 Volts (New 1948)
1—450 KVA—13,800/208 Volts—3 ph.—(network)

AIRFOIL F-D FANS, UNUSED.

2—50,000 CFM of air at 80° F against static pressure of 9.5" w.g.

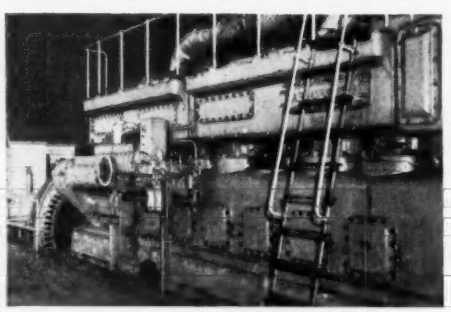
A. LEE ELLIS CO., U. S. Machy. Bldg., 140 Federal St., Boston 10, Mass:

THE BUYERS MUST BE SATISFIED—ALWAYS

MODERN SLOW SPEED
DIESEL ELECTRIC GENERATING SET

OFFERED AT CONSIDERABLE SAVING

ALSO AVAILABLE
•
WORTHINGTON
BBS
100 KW
600 RPM
3/60/480
•
Other Sets from 20 KW to 1200 KW



COMPLETE WITH ALL AUXILIARIES
—
Other Sets from 20 KW to 1200 KW

FAIRBANKS MORSE MODEL 33E16
1125 KW 300 RPM 3/60/480V

NATIONAL METAL & STEEL CORP.

1251 NEW DOCK STREET, TERMINAL ISLAND (LOS ANGELES HARBOR), CALIF.
CALL LOS ANGELES NEvada 6-9871

DIESEL DIVISION

GUARANTEED REBUILT POWER EQUIPMENT

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
2000	*G.E.	MT	257
1500	*Westg.	CW	600
1200	*Al.-Ch.	ANT	1800
600	*G.E.	MT	450
500	Westg.	CW	600
300	G.E.	IM-17B	600
250	*G.E.	IM	720
200	G.E.	IM	600
200	Westg. (2)	CW	514
200	*Westg.	CW-905A	514
150	Cr.-Wh.	50-R	1800
150	Westg.	CW	450
125	G.E. (2)	IM-15A	600
100	G.E.	IM-13A	1800
100	G.E.	MTC-5548	900
100	G.E.	IM	720
100	G.E.	IM	600
100	G.E.	IM-15A	450
75	G.E.	MT-347	1200
75	G.E.	IM	1200
75	Al.-Ch.	ARY-223C	1200
75	G.E.	MT-356	900
75	Al.-Ch.	ANY-26F	900
75	Al.-Ch.	ARY	720
75	G.E.	MT-352	720
75	G.E.	MT-556	720
75	G.E.	IM	600
60	Al.-Ch.	ARY	1200
60	G.E.	MT-546	1200
60	*G.E.	MT-536	1200
60	*Westg.	CW762C	900
50	Westg.	CW	1800
50	G.E.	IM-11A	1800
50	*Al.-Ch.	ARY	1200
50	Westg.	CW636A	1200
50	*G.E.	MT-536	1200

SLIP RING MOTORS

Crane & Hoist Service

3 phase, 60 cycle, 220 or 440 volts

H.P.	MAKE	TYPE	SPEED
80	G.E.	MTC-5552	600
75	Westg.	CI-756A	600
50	Westg.	MW-334	600
50	G.E.	HIC-TENV	600
35	G.E.	MTCV-5536	600
20	Westg.	CI	1200
11	Westg.	CI-E464	900
10	P & H	BW-6	1800
5	P & H	BW-6	1200
5	N. West.	WRC	1200
3	G.E.	MTC-5944	900

DYNAMOMETERS

250 VOLT DC WITH PANELS AND GRID RESISTORS

H.P.	MAKE	TYPE	SPEED
125	G.E. Cradle	TLC-20	2700/6000
150(3)	G.E. Cradle	TLC-50	2500/5000
200	Westg.-Block	SK-151	1350/4000

PLATERS

AMPS.	MAKE	VOLTS
7500/3750	Elec. Prod.	6/12—220/440
2000/1000	Chandy.	6/12—220/440
1500/750	Chandy.	12/24—220/440
1500/750	Chandy.	6/12—220/440
1000/500	Chandy.	12/24—220/440

SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
1250	*Al-Ch. (3)	ANX	3600
1200	*Al-Ch.	ARW	1200
750	*Westg.	CS	900
500	*Al-Ch.	ARW	3600
500	*G.E.	KT569S	900
500	G.E.	KT-424	450
350	*G.E.	KT-559A	1800
250	Westg.	CS-8120S TEFC	1800
250	G.E. (2)	KT-559	1800
250	*L-Allis	OEX-148	720
250	*G.E.	IK	600
250	G.E.	IK-17A	600
250	Westg.	CS-14	514
200	*G.E.	FT-549Y	3600
200	*G.E.	IK-13B	1800
200	G.E.	KT-564	900
200	*Westg.	CS-930A	900
200	G.E. (2)	KR-564S	720
200	Al-Ch.	ARWWT	600
150	G.E.	IE-13B	1200
150	*Al-Ch.	AN-30F	1200
150	G.E.	IK-15A	900
150	*Westg.	CS	600
125	Westg.	CS-771 Sppf	1800
125	*Al-Ch.	AR	1800
125	Westg. (2)	CS-761S	1750
125	Cr. Wh. (2)	Size 5QR	1200
125	*Reliance	AA 6085	900
125	Al. Chal.	AN	514
100	Westg.	CS5075 TEFC	3600
100	*Westg.	CS-760A	1800
100	*G.E.	FT-542Z	1800
100	G.E.	FTRP-543	1800
100	*Westg.	CS-760D	1200
100	G.E.	KT-553	1200

D. C. MOTORS

H.P.	MAKE	TYPE	SPEED
250	Westg.	SK-220	450/600
200	Reliance (2)	1400T	350/1200
200	Westg.	SK-201	650
200	Cr. Wh.	CM	500
175	G.E.	ELC	750
100	G.E.	MPC	400/800
100	G.E.	RC-34	2500
100	G.E.	RC-19	575
100/150	G.E.	MCF	380/1000
50	Cr. Wh.	CMC	700/1100
35	Westg. (2)	SK150	350/1000
30	Cr. Wh.	CCM-504	450
30/40	G.E. (2)	CD-123	400/1600
30/40	G.E.	CD-115	500/1500
25/30	G.E. (2)	RF-12	500/1500
25	G.E.	RC-32	800
25	Westg.	SK-133	575
20/25	Westg.	SK-151L	250/1000

M.G. SETS

K.W.	MAKE	A.C.	D.C.
1250	Westg.	6600/4160	600
1000	G.E.	12000	600
560	Westg.	2300	125/250
400	A.C.	2300	120/240
300	Westg.	2300/440	250
200	G.E.	2300	250/275
200	Westg.	2300/4000	250/275
200	Ridgeway	2300	250
170	G.E.	440	125
150	G.E.	2300	125 2[illegible]
150	A.C.	2300	275
150	Westg.	2300	125/2
150	G.E.	440	275
125	Cr. Wh. (3)	4160	125
100	G.E.	2300	250
100	Al-Ch.	2300	250
100	Elec. Mch.	440	125

CHICAGO *Electric Co.* 1320 WEST CERMAK RD., CHICAGO 8, ILL.

TURBO-GENERATORS

2500 KW G.E. Non-C. 3/60/2400/4160 V 3600 RPM 185 PSIG 30# BP

2000 KW Allis, Cond. 3/60/2400 V. 3600 RPM 400 PSIG 600# TT

300 KW G.E. Non-C., 3/60/480 V 3600 RPM 150 PSIG 5# B.P.

Full line power equipment

BREW, WOLTMAN & CO., INC.

50 Church St., New York 7, New York

DIESEL GENERATOR SETS

2—McIntosh-Seymour (Alco) 950 HP 8 cyl. 225 RPM, 875 KVA Westinghouse 3 phase, 25 or 60 cycle alternators. 20 KW exciters.

1—McIntosh-Seymour (Alco) 600 HP 5 cyl. 225 RPM, 500 KVA General Electric 3 phase, 25 or 60 cycle alternator. 15 KW exciter.

Complete plant installation with all accessories. Priced attractively. With or without generators.

MISSISSIPPI VALLEY EQUIPMENT CO.

611 Olive St. • St. Louis 1, Mo.

B & W BOILER

66500#-Hr., 650#, 750°F. 4-DRUM STERLING TYPE. Complete in all Respects.

CHARLES WEAVER, M.E.
19701 JAMES COUZENS HIGHWAY
DETROIT 35, MICHIGAN

875 KVA DIESEL GENERATOR UNUSED

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37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
800	2300	Whse.	900
500	4000/2300	G.E.	600
450	440	Whse.	514
400(2)	2300	G.E.	900
400	2200	Whse.	450
300	4000/2300	G.E.	720
300	440	G.E. (hoist)	600
300	440	Whse.	3600
250	2200/440	G.E.	1200
250	440/220	Whse.	600
250	550/440	G.E.	1200
225	4000/2300	G.E. (hoist)	600
200	440/220	Whse.	514
200	2200/440	G.E.	600
150	440/220	Whse.	720
150	2200/440	G.E.	600
125	2200	G.E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G.E.	ATI	720
375	2200	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G.E.	TS	720
300	2200/440	G.E.	TS	1200
250	440/220	G.E.	ATI	600
150	440/220	G.E.	TS	720
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2200	G.E.	FT	3600
500	2200/4000	Elliot	SC	1800
350	440	G.E.	KT	1200
300(2)	2200	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
250	440-220	G.E.	KT	720
250	2300	Whse.	CS	600
200	440-220	G.E	KT	1800
200	2200	G.E.	KT	1800
150	2200	Al. Chal.	AR	1800
150	440/220	G.E.	KT	720
150	2200/440		KT	600
150	2200/440	G.E.	FT	1200
125(2)	2200/440	Whse.	X-proof	720
125	2200/440	G.E.	K	600
100(2)	4000/2300	L. Allis	OX	1200

A. C. GENERATORS

1—320 kva, 660 rpm 2300/440/220 V., G.E.
1—300 kva, 900 rpm, 2200 V., Whse.
1—225 kva, 60 rpm, 220/440 V., G.E.
1—200 kva, 720 rpm, 2200/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKR-155-28, 600 amp., 15,000 V. G.E.
1—400 Amp., Condit, 3P, 25 KV outdoor
1—400 Amp., R. Smith, 3P, 7.5 KV outdoor

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	1800
150	230	El. Dyn.	B/brg.	600
150	230	Whse.	SK	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2200	Syn.	250
150	Whse.	440/220	Sq. Ca.	275
125	G.E.	4000/440	Syn.	125
75	Cr. Wh. (unused)	440/220	Sq. Ca.	240/120
65	G.E.	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—1000 kva, Whse., 13,800—2300 V., 3 ph., New
1— 600 kva, Standard, 13,800—2300 V., 3 ph.
3— 500 kva, G.E., 13,800—2300 V.
3— 333 kva, G.E., 13,800—2300 V.
3— 333 kva, G.E., 2400—480 V.
2— 300 kva, G.E., 4150—240 V., 3 ph., Pyr.
3— 200 kva, G.E., 2400—120/240 V.
3— 200 kva, Mol., 13,800—2300 V.
3— 150 kva, Al. Ch., 2400—220 V.
3— 150 kva, Al. Ch., 440-220 V., dry, New
3— 100 kva, Al. Ch., 440-220/110 V., dry, New

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6 MOTOR GENERATOR SETS

No.	KW	Make	Input V. AC	Motor Type	Output V. DC
1	60	GE	550	sq. ca.	125
1	65	GE	550	sq. ca.	125
1	100	GE	550	sq. ca.	125
2	40	GE	550	sq. ca.	125
1	150	GE	550	syn.	125

No.	Make	Type	Speed	Volts	H.P.	Phase	Cycle
18	GE	L	600- 900	550	125	3	40
24	GE	L	600-9000	550	175	3	40

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268 CFM	500 PSI	10-4½x10 Ingersoll XOB
284 CFM	100 PSI	Chic. PE 450 HP
420 CFM	40 PSI	12x9 Ing ESI (New)
440 CFM	50 PSI	13x10 Worth—all-less
552 CFM	100 PSI	13-8"x12 Ingersoll XRB
502 CFM	125 PSI	12x13 Chic T
676 CFM	100 PSI	15-9½x12 Worth
593 CFM	100 PSI	13½-8x8 IR-XRE
868 CFM	100 PSI	17—10x12 CP-OCE
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D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	EW	350	1000
200	Allis Ch. b.b.	EW	250	600/900
175	Cr. Wh.	151-H	230	500
150	Whse.	SK-184	230	650
100	Reliance	651-T	550	1000/1600
100	Reliance	651-T	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
75/150	Whse.	SK-200	230	400/1000
75	Gen. Elec.	RF-16	230	450/900
75	F. Morse b.b.	DH-140	115	1600
60	G.E. TEFC b.b.	CD-135	230	1150
50	Gen. Elec.	CD-95	230	1800
50	Star b.b.	SQ-92	230	680
50	G.E. (3)	CD-125	230	400/1200
40	Reliance b.b.	131-T	550	1750
40	G.E. (2)	CD-93	230	1750

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V.
250	Allis Ch.	2200/440 AC	250 DC
200	Whse.*	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Whse.	2300 AC	250 DC
175	Gen. Elec.	220/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
100	G.E.*	2200/440 AC	125 DC
100	Whse.	220/440 AC	250 DC
75	G.E. converter	440 AC	250 DC
75	G.E.	220/440 AC	125 DC
60	Whse.	220/440 AC	250 DC
50	Gen. Elec	220/440 AC	125 DC
50	Cr. Wh. b.b. (2)	220/440 AC	250 DC
35	Gen. Elec.	220/440 AC	125/250 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
250	Allis Ch. b.b.	EW	350	1200
200	Allis Ch. b.b.	EW	250	900
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CCD	250	650
100	Whse.	SK-180	250	900
100	Allis Ch.	E	125	1200
100	Reliance	651-T	600	1200
75	F. Morse b.b.	DG	125	1800
60	Allis Ch. (3)	E-146	250	1800
60	Ideal	D-326	125	1150

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
700	G.E.	Slipring	220/440	1800
600	G.E.	Slipring	2300	600
500	Whse.	Slipring	2200	450
450	Allis Ch.	Synch.	480	400
400	Whse. (2)	Synch.	2200	1800
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2200	3600
350	G.E.	Sg. Cage	2200	1800
350	Cont. b.b.	Slipring	2300	900
300	El. Mchy (2)	Synch.	2200/440	360
300	Whse.	Synch.	440	1200
300	G.E.	Slipring	440	450
300	Allis Ch.	Sq. Cage	2200/440	720
250	G.E.	Slipring	440	1800
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Slipring	220/440	720
250	Gen. Elec.	Synch.	220/440	450
250	Whse.	Slipring	440	1200
250	G.E.	Sq. Cage	2200	1800
250	Allis Ch.	Synch.	440	360
225	G.E.	Synch.	220/440	900
200	G.E.	Sq. Cage	2200/440	1200
200	Whse. (2)	Slipring	2200	514
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2200/440	900
200	G.E. (2)	Sq. Cage	2200	514
175	G.E. (2)	Synch.	220/440	720
150	U.S. b.b.	Sq. Cage	220/440	1800
150	El. Machy.	Synch.	220/440	450
150	G.E. (4)	Slipring	2200/440	600
150	G.E. (2)	Sq. Cage	2200/440	720
150	Cr. Wheeler	Sq. Cage	220/440	450
150	G.E.	Slip Ring	220/440	450
125	Whse. TEFC	Sq. Cage	2200/440	720
125	G.E. TEFC	Sq. Cage	220/440	3600
125	Ideal	Slipring	4000/2200	900
100	Whse. TEFC	Sq. Cage	2200/440	1200
100	Whse. (2)	Sq. Cage	2200	900

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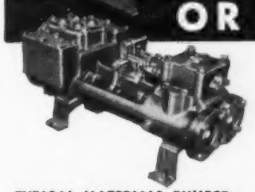

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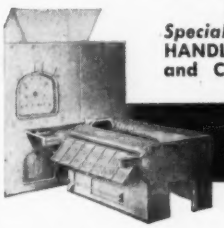

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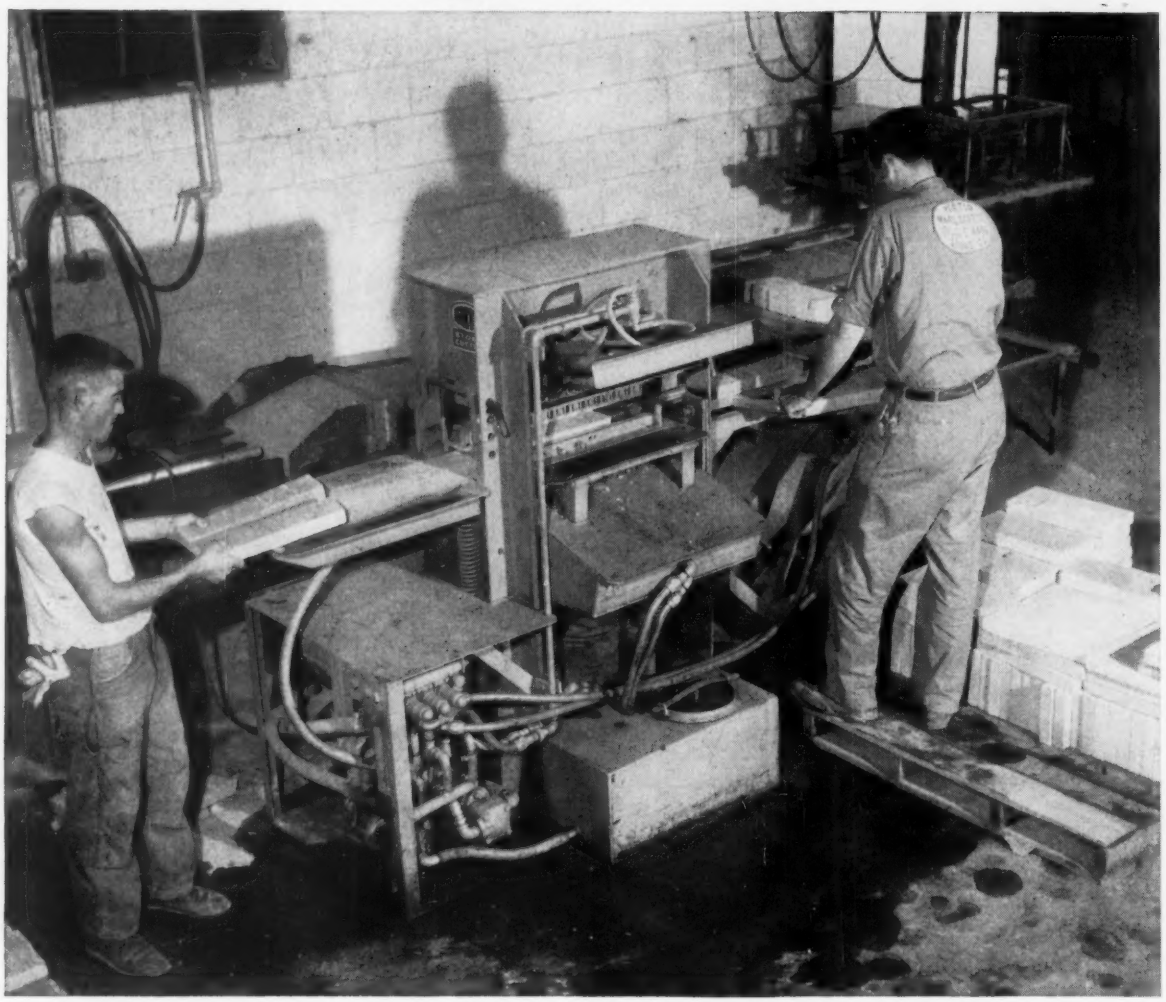

Machine cuts stone like paper

B. F. Goodrich improvements in rubber brought extra savings

Problem: This machine that cuts stone like a paper cutter is run by hydraulic power. Pressure as great as a ton for each square inch shoots through hydraulic lines.

Years ago, when hydraulic power was developed for all kinds of powerful machines, a flexible connection was needed. Rubber hose wasn't strong enough. Vibration wrecked metal tubing. For a while it seemed there would never be anything that would stand the sudden surges of hydraulic oil and still be flexible.

What was done: B. F. Goodrich engineers began experiments for stronger hose. They developed one that combines rubber for flexibility, steel for strength. Using steel wire, almost as fine as hair, they found a new way of braiding it, using a half mile of wire for every foot of rubber hose.

Savings: B. F. Goodrich hose has been in use on these stone-cutting machines over four years now, with no leaks, no bursts. So far as anyone knows the hose will last as long as the machines.

Extra benefits: B. F. Goodrich has made many other improvements. The tube is special to allow couplings to grip firmly, stay on longer without leaking. This kind of tube costs more to make but gives extra value far beyond cost.

Where to buy: Your B. F. Goodrich distributor has full information on these improvements, plus exact specifications on the hose described here. And, as a factory-trained specialist in rubber products, he *can* answer your questions about all the rubber products B. F. Goodrich makes for industry. *B. F. Goodrich Industrial Products Co., Dept. M-857, Akron 18, Ohio.*

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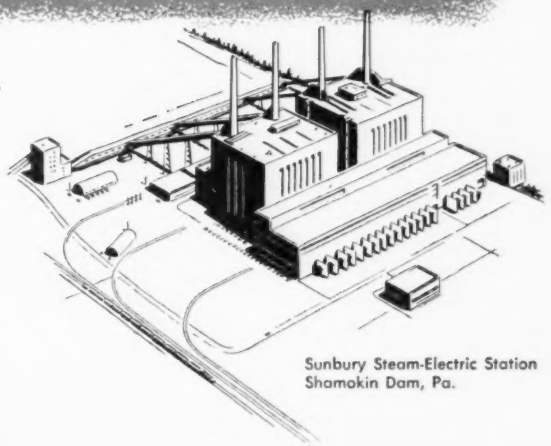
Grinnell
prefabricated piping
for 16 years

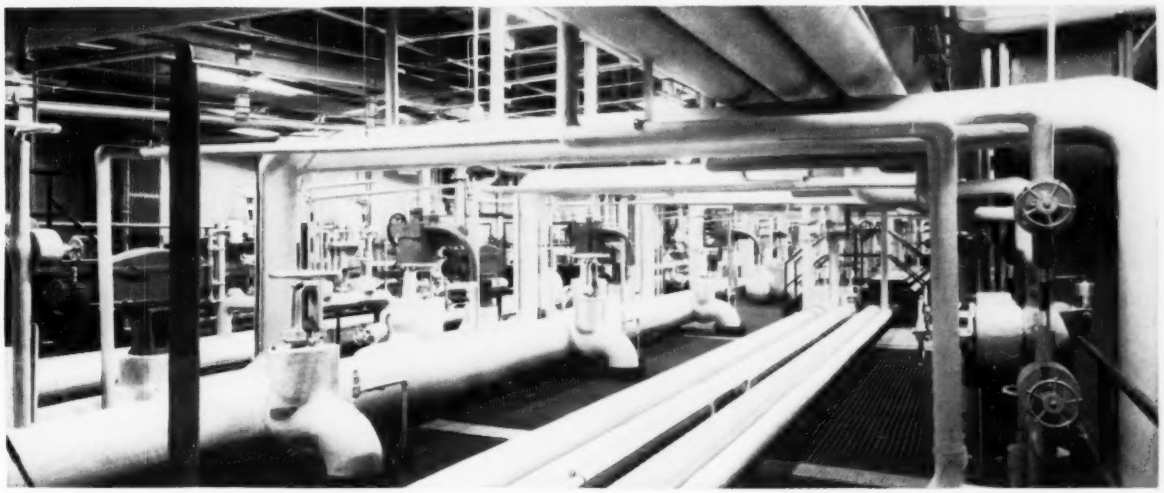
Since 1940, Pennsylvania Power & Light Company has awarded *all* its prefabricated piping work to Grinnell. Some idea of the extent of this confidence in the competence and skill of Grinnell piping specialists can be drawn from the fact that during this 16-year period there were 8 new units installed — with a total capability of close to 800,000 kw's.

Among other companies in the power field which have indicated a marked preference in the past for Grinnell Piping Products are Duke Power, a Grinnell Prefabricated Piping user for 44 years; New England Electric System, a 6-year, 6-time repeat customer; and Carolina Power & Light, a 7-year, 7-time Grinnell repeat customer.



Sunbury Steam-Electric Station
Shamokin Dam, Pa.

Where some of the 4,500 individual fabricated piping assemblies made by Grinnell were installed at the Sunbury Station.



The big jobs in power piping go to Grinnell because Grinnell's shop facilities offer these practical advantages . . . superior quality of finished product; faster "on the job" assembly; lower final cost. Assign *your* next piping job to Grinnell.

Work done by Grinnell for Pennsylvania Power & Light Company

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1941-42	Hauto Station, Unit #6
1949	Sunbury Station, Units 1 & 2
1950	Sunbury Station, Unit #3
1953	Sunbury Station, Unit #4
1954	Martins Creek Sta., Unit #1
(Scheduled Completion)	
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HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 1 OF A SERIES)

Aerators, Degasifiers, Deaerators

If you want to remove dissolved gases or iron or taste and odor from large quantities of water, you will probably use aeration or degasification as part of the treatment.

Modern equipment for putting air or gases into water or taking them out is highly specialized, ranging from simple, low cost aerators to complex, highly efficient degasifiers.

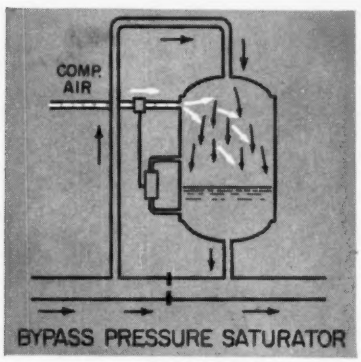
The following descriptions may help you choose the type of equipment that best solves your problem at the lowest cost.

To introduce air

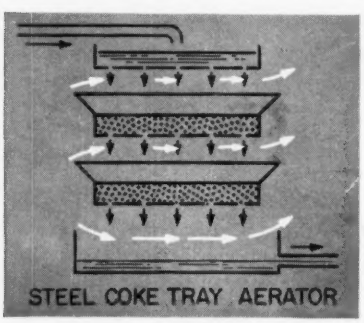
If your problem is simple introduction of air to oxidize iron or manganese, **pressure aeration** may be preferred to avoid repumping. But introducing air into water under pressure can result in supersaturation when the pressure is reduced, causing "milky water" and filter troubles from air binding or upset beds.

A Bypass Pressure Saturator automatically provides aeration without the danger of supersaturation by introducing air to only a predetermined portion of the total flow. (Patented by Permutit.)

If you want to reduce CO_2 or taste and odor or accomplish any of these at the same time that you oxidize iron or manganese, an **aerator** is recommended.

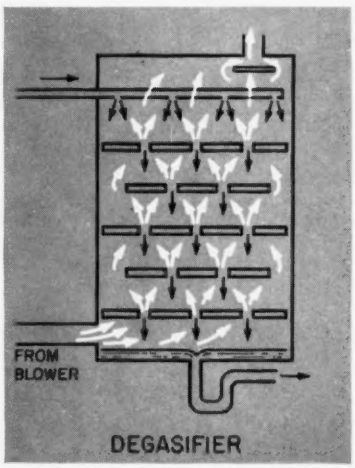


Aerators may be of the open type in which water cascades over trays of graded coke or a series of wood slat trays. Splash aprons reduce splashing, permit free circulation of air. Formation of iron or manganese film on coke surfaces hastens oxidation reactions. Some reduction of CO_2 may also take place, raising pH and further helping oxidation.



To remove dissolved gases

For practically complete removal of CO_2, methane, hydrogen sulfide or other gases, the most efficient way is by a **degasifier.**



In a degasifier, water rains down through Raschig rings or wood slat packing countercurrent to a large flow of air from a blower. Thus the freshest air contacts the effluent water, gives lower final gas content. Proper packing design breaks water into thin films, promotes rapid and efficient gas removal.

Degasifiers are totally enclosed, avoiding splashing and spray losses. Outer tank may be of wood, rubber-lined steel, stainless steel or aluminum. Cylindrical units are usually more economical, but square or rectangular shapes may be used. Sizes and capacities are practically unlimited, depending on requirements. Units can be used for water with CO_2 as high as 3500 ppm.

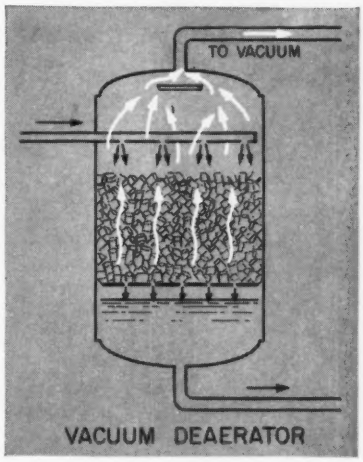
Although degasifiers provide very complete aeration, their higher cost is unwarranted in many cases where simple introduction of air is the main objective.

To remove oxygen

If you want to remove oxygen without heating the water, use **vacuum deaeration.**

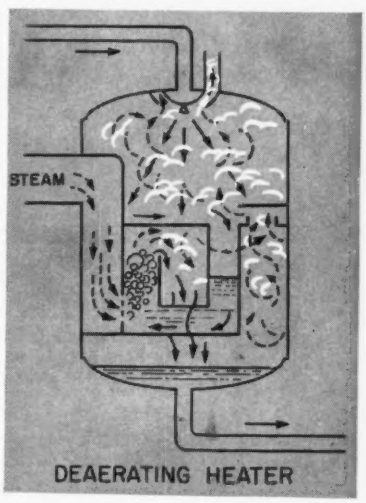
A vacuum deaerator is a steel tank lined where necessary and containing suitable packing such as Raschig rings. A vacuum is maintained in the tank by steam jet ejectors or motor-driven vacuum pumps. Under a vacuum, solubility of gases in water is greatly lowered. As the water trickles down through the packing, the gases present, including oxygen, nitrogen and carbon dioxide, are liberated and drawn off. Type and depth of packing, degree of vacuum, flow rates and other variables must be accurately adapted to your specific conditions for best efficiency.

If the water is to be heated as for feeding boilers, a vacuum is not necessary, and a **deaerating heater** is recommended.



In a spray type deaerating heater, the water is first sprayed through steam which removes most of the non-condensable gases. (The gas-laden steam is condensed and vented.) The water is then reboiled by passing steam through it for final deaeration.

Where less complete removal of oxygen is required, the reboiling (scrubbing) stage may be omitted.



For detailed information on these or any other types of water-conditioning equipment, write: The Permutit Company, Dept. P-2, 330 West 42nd St., New York 36, N.Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

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